Draft Environmental Assessment of the SH Dam Removal

Prepared By:

Allied Engineering Services, Inc

For:

Montana Fish, Wildlife and Parks Region 7

March, 2008

Table of Contents

List of Figures

List of Tables

List of Photos

1.0 PURPOSE AND NEED FOR ACTION


Photo 1: SH Diversion Dam View South Taken 9/21/07.

The 2007 Montana Legislature appropriated $270,000 for the removal of the SH Dam. The purpose statement under HB 837 included, removal or modification of three water diversion projects on the Tongue River would add 177 miles of critical, unimpeded spawning and rearing habitat for several native warm-water fish species that have disappeared from the Tongue River and that are declining throughout their range in eastern Montana. Origins of these statements were not researched as part of this report, but appear consistent with other reports conducted on the Tongue River by Confluence, Inc. (2007), Elser & Mcfarland (1977), and others.

1.1 Proposed Action

Montana Fish, Wildlife and Parks (FWP) proposes removal of the SH Dam to restore migration of native warm-water fish species that live in the Yellowstone River and its tributaries, including the pallid sturgeon, and species of special concern, such as the blue sucker, sturgeon chub, paddlefish and sauger.

1.1.1 Funding

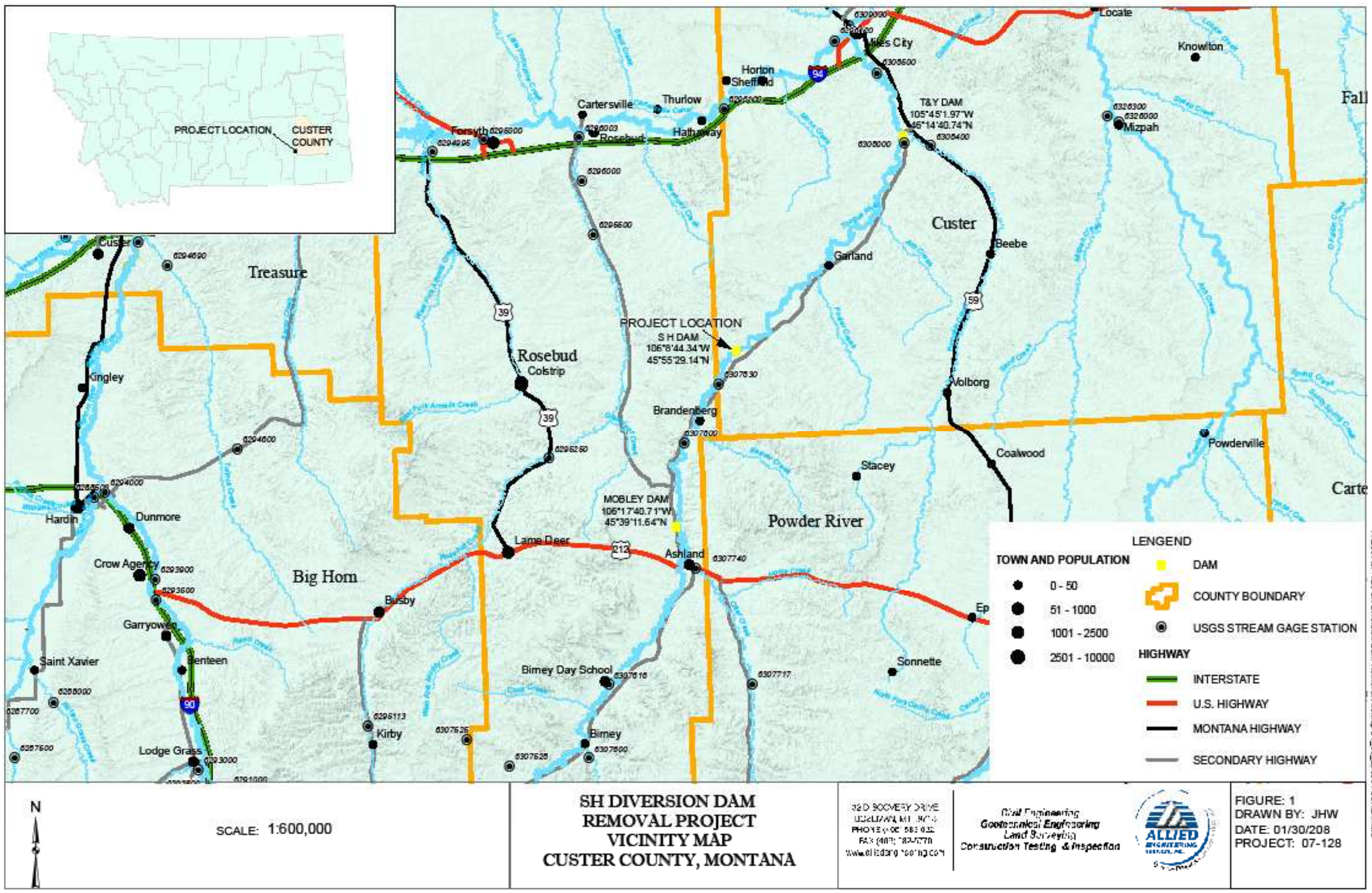
The project was appropriated by HB 2, Montana 60th Legislature funded from Operations & Maintenance Funds in the amount of $270, 000.

1.2 Location and Setting

The SH Dam is located approximately 45 miles southwest of Miles City, MT in the southwest ¼ of Section 16, Township 2 North, Range 45 East (P.M.M.). The coordinates of the project site are Lat. 45.924798°, Long. -106.145579° (WGS 84). The SH Canal System was privately built between 1901 and 1908. The system was owned and operated by the SH Ranch. According to a local landowner, the original cribbed log diversion dam was converted to concrete structure during the 1930's (Confluence, 2007). Surrounding land use in the area is primarily agricultural with grazing and irrigated crop production.

Photo 2: SH Dam View North Taken 11/26/07

Figure 1: Vicinity Map



1.2 Need for Action

Historic diversion dams along the Tongue River have disrupted the natural flow regime and have altered the physical, chemical and biological processes affecting the Tongue and Yellowstone River ecosystems. Restriction of fish and aquatic organisms from their native spawning habitats has contributed to population stagnation and extirpation particularly of species of special concern associated with the warm-water fisheries.

1.3 Objectives of the Action

1.3.1 Objective 1

The primary objective of the SH Dam removal is to re-establish an unobstructed river channel with natural riverbed and bank conditions on the Tongue River that will provide unimpeded access to fish and other aquatic organisms above the existing dam.

1.3.2 Objective 2

Complete dam removal project within specified project budget.

1.4 Relevant Documents and Plans

1.4.1 SH Dam Removal Conceptual Design and Planning Report

The SH Dam Removal Conceptual Design and Planning Report was prepared for the US Fish and Wildlife Service and Montana Fish, Wildlife and Parks to provide conceptual dam removal alternatives, potential impacts, and estimated implementation costs. The report was completed By Confluence, Inc. and HKM, Inc. dated May 15, 2007. The report outlines existing conditions, two removal options, sediment disposal options, restoration conceptual plan, potential impacts of dam removal, environmental permitting requirements, sediment sampling and analytical laboratory analysis and a project cost analysis. The report also includes topographic survey data in the area of the SH Dam. A topographic profile of the river channel was surveyed approximately 3,400 feet upstream of the dam and about 600 feet downstream of the dam. A total of eight cross-sections (including the dam crest) were surveyed.

1.5 Decision(s) That Must be Made

Decisions will need to be made to determine if the alternatives analysis meets the project objectives, which alternative should be selected and to determine if the proposed selected alternative will require further analysis or study.

1.6 Scope of This Environmental Analysis

1.6.1 History of the Planning and Scoping Process

An article in the Billings Gazette attributed fish habitat restoration desires as long as 40 years ago on the Tongue River. More recently, the 660-foot long Muggli Fish passage was dedicated on September 19, 2007 and provides access around the T&Y Diversion Dam.

The 2007 Montana legislature approved funding for finishing the T&Y project, removal of the SH Dam and the Mobley Dam, and a feasibility study for removal of the Cartersville Dam on the Yellowstone River near Forsyth.

Confluence Inc. completed conceptual design and planning for removal of the SH Dam for Montana Fish, Wildlife and Parks and the US Fish and Wildlife Service in a report dated May 2007. Project details and direction for an environmental assessment of alternatives as well as development of construction documents were outlined in a letter to Allied Engineering dated November 5, 2007 from Montana Fish, Wildlife and Parks.

An on-site meeting was held at the SH Dam including personnel from Montana FWP, The Nature Conservancy, Allied Engineering Services, Inc, Mainstream Restoration, Inc. and Mr. Ray Harwood (adjacent landowner) to discuss project history and dam removal options.

1.6.2 Issues Studied in Detail

1.6.2.1 Surface and Groundwater Resources (Issue 1)

Dam removal may result in localized changes in surface and groundwater elevations in the vicinity of the diversion structure.

1.6.2.2 Soil/Land Resources (Issue 2)

Removal of the diversion could affect the soils immediately adjacent the Tongue River and alter erosion patterns, deposition and siltation.

1.6.2.3 Air Quality (Issue 3)

Construction operations and post- construction exposed soil can result in increased airborne particulate matter that could provide a nuisance for nearby residents and farming operations.

1.6.2.4 Water Quality (Issue 4)

Dam removal could have significant short-term water quality effects during and following construction due mainly to accumulation of sediments behind the dam and the potential for significant increases in turbidity and sediment mobility. Pollutants that could be stored in sediments could also contribute to water quality degradation. There is also the potential for construction equipment release of hydrocarbons directly into the stream in the event of equipment malfunction or fuel spillage.

1.6.2.5 Vegetation/Wetlands (Issue 5)

The conversion of fringe wetland species to herbaceous and woody upland meadow species could be a direct result of dam removal due to the lowering of water elevation.

1.6.2.6 Weeds (Issue 6)
Construction operations and water elevation change will result in exposed soil that could be vulnerable to invasion by undesirable invasive plant species.

1.6.2.7 Fisheries (Issue 7)
Although the removal of the dam is anticipated to restore upstream fish passage and thereby provide access to presently inaccessible fish habitat, construction operations and removal of the dam could have long-term detrimental effects on some species and significant short-term impacts on the entire fishery downstream of the dam.

1.6.2.8 Wildlife (Issue 8)
The dam removal could affect species diversity and distribution in the immediate area through habitat conversion.

1.6.2.9 Threatened and Endangered Species (Issue 9)

1.6.2.9.1 Pallid Sturgeon (G1, S1)
Although the pallid sturgeon has not been documented in the Tongue River upstream of its confluence with the Yellowstone River, the dam removal could create disturbance(s) and/or alter habitat for the pallid sturgeon.

1.6.2.10 Species of Special Concern (Issue 10)

1.6.2.10.1 Bald Eagle (G5, S3)
Recently delisted by the USFWS, bald eagle habitat could be disturbed and altered as the dam removal could cause vegetation conversion.

1.6.2.10.2 Brewer’s Sparrow (G5, S2B)
The dam removal could create disturbance(s) and alter habitat for the Brewer’s sparrow through vegetation conversion.

1.6.2.10.3 Loggerhead Shrike (G4, S3B)
The dam removal could create disturbance(s) and alter habitat for the loggerhead shrike through vegetation conversion.

1.6.2.10.4 Greater Sage-Grouse (G4, S3)
The dam removal could create disturbance(s) and alter habitat for the greater sage-grouse through vegetation conversion.

1.6.2.10.5 Sauger (G5, S2)
The dam removal could create disturbance(s) and alter habitat for sauger.

1.6.2.10.6 Blue Sucker (G3,G4, S2,S3)
The dam removal could create disturbance(s) and alter habitat for blue sucker.

1.6.2.10.7 Sturgeon Chub (G3, S2)
The dam removal could create disturbance(s) and alter habitat for sturgeon chub.

1.6.2.10.8 Sicklefin Chub (G3, S1)
The dam removal could create disturbance(s) and alter habitat for sicklefin chub.

1.6.2.10.9 Paddlefish (G4, S1,S2)
The dam removal could create disturbance(s) and alter habitat for paddlefish.

1.6.2.11 Community Impact (Issue 11)
The dam removal could impact downstream water users due to short-term increased turbidity.

1.6.2.12 Aesthetics (Issue 12)
Dam removal will change the appearance of the river.

1.6.2.13 Recreation (Issue 13)
Removal of the dam could affect recreation in the area in terms of fishing and boating.

1.6.2.14 Cultural and Historical Resources (Issue 14)
The dam is a historical structure. Removal would result in the physical loss of this resource type.

1.6.2.15 Public Controversy (Issue 15)
Removal of dams and construction operations in rivers can generate public controversy.

1.6.3 Issues Eliminated From Further Study

1.6.3.1 Soil and Land Resources (Issue 1)
The dam appears to be constructed on somewhat exposed sandstone belonging to the Lebo Member of the Fort Union Formation (US Geological Survey, 1998). Soils generally originate from eroding bedrock and alluvial terraces and include fine sand, silts and some clay textures (NRCS, 2007). No detrimental effects to surrounding land use or productivity are anticipated. Some short-term effects may be encountered associated with construction activities, including haul roads and dam disposal. However, these effects are relatively isolated and small scale. Erosion control measures and reclamation of disturbed areas would mitigate potential harmful effects.

1.6.3.2 Air Quality (Issue 3)
The primary concern for air quality is dust generated by construction activities associated with the dam removal and dust generated following construction originating from areas of exposed soil. However, construction activities are not anticipated to create significant amounts of airborne particulate matter. In the event of significant generation of nuisance dust during construction, abatement through application of water can correct this problem and can be contractually addressed in the construction documents. Temporarily exposed

soil following construction could contribute to nuisance dust during significant wind events, but will be abated as vegetation is established during the growing season. FWP personnel can monitor nuisance dust as part of site monitoring and stay in contact with the only likely affected nearby residents and abate if necessary.

1.6.3.3 Weeds (Issue 6)

Establishment of weeds as part of construction will be mitigated through reclamation and seeding of disturbed areas using native plant species. Areas of bare soil exposed due to lower water elevation should have sufficient seed source to regenerate naturally. Weedy species may pioneer these areas initially, but native vegetation should be established within 2-3 growing seasons and will eventually out-compete weeds. All removal alternatives will include monitoring and weed management if necessary.

1.6.3.3 Fisheries (Issue 7)

Since the dam is presently a barrier to fish passage, the anticipated result of removal will be beneficial to the fishery. Some species may be negatively affected in the long- term through habitat conversion, but the overall benefits, especially for threatened species and species of special concern, will likely outweigh negative impacts. Impacts to water quality are discussed in Sections 3.0 and 4.0.

1.6.3.4 Wildlife (Issue 8)

Wildlife habitat conversion will likely take place in the immediate vicinity of the diversion structure, but long-term effects from removal should be minimal. A discussion of relevant habitats is provided in Sections 1.6.3.1 and 1.6.3.2 below.

1.6.3.5 Threatened and Endangered Species (Issue 9)

The pallid sturgeon is listed as endangered by the US Fish and Wildlife Service (USFWS) and US Forest Service (USFS), as Special Status by the Bureau of Land Management (BLM) and as S1/G1 by the Montana Natural Heritage Program (MNHP). The ranking by MNHP indicates high risk because of extremely limited and/or rapidly declining numbers, range and/or habitat, making it highly vulnerable to global extinction or extirpation in the state.

The pallid sturgeon is the only listed species raised as an issue due to the Tongue River being a tributary of the Yellowstone River where the pallid sturgeon is found. The pallid sturgeon likely inhabited and spawned in the Tongue River historically. The reason for eliminating this issue from further study is that turbidity generated from construction activity and sediment release, due to impounded sediment erosion, would be beneficial to the warm water fishery. Suspended sediments play an important role in river ecology and provide cover for warm water fishes allowing them to migrate. In addition, the project may in fact benefit the pallid sturgeon by opening additional habitats through increasing 100 plus river miles (Brad Schmitz, FWP Region 7 Fisheries Manager; personal communication, December 18, 2007).

1.6.3.6 Species of Special Concern (Issue 10)

1.6.3.6.1 Bald Eagle (G5, S3)

The bald eagle was delisted by the USFWS in August of 2007, but is still protected under the Bald Eagle Protection Act. The Act prohibits the taking or possession of and commerce in bald and golden eagles, with limited exceptions. Bald eagles have been seen in the area, and a nesting brood was apparent this year several miles downstream of the SH Dam (personal communication on December 20, 2007 with Mike Backes, Fisheries Technician, Region 7 FWP). Bald eagle habitat is also apparent adjacent to the SH Dam where a stand of cottonwoods occur primarily on the south shore of the river with scattered cottonwoods occurring along both banks of the river. Water elevation changes as part of dam removal will not likely have a significant impact on cottonwoods (bald eagle habitat), since cottonwoods can tolerate a groundwater range within what is expected as a result of dam removal.

1.6.3.6.2 Brewer’s Sparrow (G5, S2B)

According to the Montana Natural Heritage Program, state ranking Brewer’s sparrows are at risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to global extinction or extirpation in the state. The modifier “B” rank refers to the breeding population of the species in Montana. Global ranking refers to this species as common, widespread and abundant (although it may be rare in parts of its range). In Central Montana, Brewer's sparrows nest in sagebrush averaging 16-inches high. The cover (concealment) for the nest provided by sagebrush is very important (MNHP, 2007).

Since Brewer’s sparrows rely primarily on sagebrush/steppe habitats. Some options include sediment disposal in nearby upland areas that would temporarily impact potential habitat, but impacts will have little or no effect on this habitat type and little, if any, impact on the Brewer’s sparrow.

1.6.3.6.3 Loggerhead Shrike (G4, S3B)

State ranking S3B includes the loggerhead shrike as potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas. Global ranking refers to this bird species as uncommon but not rare (although it may be rare in parts of its range), and usually widespread. It is apparently not vulnerable in most of its range, but its presence could possibly be cause for concern.

The loggerhead shrike generally prefers open areas for breeding and habitat including hedgerows and fence lines. In Idaho, the majority of nesting occurres in sagebrush (MNHP, 2007). According to the Montana Natural Heritage Program, evidence of breeding has been documented in Rosebud and Custer Counties (near the SH Dam removal project).

The indications that loggerhead shrikes prefer habitats that will not be significantly impacted by this project, lead to removal of this species from further study.

1.6.3.6.4 Greater Sage-Grouse (G4, S3)

The greater sage-grouse in Montana ranks as potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas. Global ranking refers to this bird species as uncommon but not rare (although it may be rare in parts of its range), and usually widespread. The Montana Comprehensive Fish, and Wildlife Strategy identified the greater sage-grouse as a Tier 1 species of “greatest conservation need.” Montana Fish, Wildlife and Parks has a clear obligation to use its resources to implement conservation actions that provide direct benefit to these species, communities and focus areas (MFWP, 2005).

The greater sage-grouse relies primarily on a sagebrush/steppe habitat, and the project will have little or no effect on this habitat type. Therefore, there should be little, if any, impact on the greater sage-grouse.

1.6.3.6.5 Sauger (G5, S2)

State ranking for the sauger classifies it as at risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to global extinction or extirpation in the state. Global ranking refers to this species as common, widespread and abundant (possibly rare in parts of its range) not vulnerable in most of its range. The Montana Comprehensive Fish and Wildlife Strategy ranks the sauger as a Tier 1 species of “greatest conservation need.” Montana Fish, Wildlife and Parks has a clear obligation to use its resources to implement conservation actions that provide direct benefit to these species, communities and focus areas (MFWP, 2005).

Montana FWP personnel from Region 7 sampled fish weekly from mid-April through July 10, 2007 on the Tongue River. Observations of fish species included sauger, and spawning evidence was documented below the T&Y Dam about 12-miles south of Miles City. However, sauger was not identified above the T&Y Dam (personal communication Mike Backes, Fisheries Technician FWP, Region 7). According to the Montana Natural Heritage Program website the Tongue and Powder Rivers are vital spawning areas for the Yellowstone River population (MNHP, 2007). Sauger inhabit the larger turbid rivers and the muddy shallows of lakes and reservoirs. They spawn in gravelly or rocky areas in shallow water and seem to prefer turbid water (MNHP, 2007). Both Brad Schmitz and Mike Backes with Montana FWP, Region 7 confirmed that warm water species including sauger rely on turbid water for cover and spawning and are accustomed to turbid flow during all seasons following significant storm or thaw events.

Sauger are expected to utilize the recently completed Muggli Fish Passage and migrate upstream of the T&Y Dam in the spring of 2008, provided that average or above average flow is maintained in the Tongue River. SH Dam removal options include construction activities in the fall after the period of migration and spawning and would not likely have a significant effect on sauger population.

1.6.3.6.6 Blue Sucker (G3, G4, S2,S3)

Dual global ranking describes the blue sucker as potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas (G3), and as uncommon but not rare (although it may be rare in parts of its range), and usually widespread. The blue sucker is apparently not vulnerable in most of its range, but possibly cause for long-term concern (G4). Similarly, dual state ranking includes; at risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to global extinction or extirpation in the state (S2) and as outlined above in G3 descriptions.

According to the Montana Chapter of the American Fisheries Society, the species is currently described as widespread throughout the USA and in Montana. There are no known blue sucker populations that have been extirpated. However, where extensive riverine losses have occurred due to impoundments, there have been major population losses and blue sucker populations have been fragmented. In Montana, the blue sucker is present in most places that have available habitat. The lower Yellowstone River blue sucker population would probably exist farther upriver if the Cartersville Dam and other diversion dams on the Yellowstone did not restrict upriver passage (American Fisheries Society, 1998). Montana FWP personnel from Region 7 sampled fish weekly from mid-April through July 10, 2007 on the Tongue River. Observations of fish species included blue suckers and spawning evidence was documented below the T&Y Dam about 12-miles south of Miles City. However, Blue suckers were not identified above the T&Y Dam (personal communication Mike Backes, Fisheries Technician FWP, Region 7).

Removal of the SH Dam will generally open spawning habitat historically restricted to the region below the T&Y Dam for blue suckers. Potential short-term impacts associated with sediment suspension and deposition following dam removal include construction activities in the fall after the period of migration and spawning and would not likely have a significant effect on blue suckers.

1.6.3.6.7 Sturgeon Chub (G3, S2)

Global ranking describes the sturgeon chub as potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas. The chub’s state ranking is described as at risk because of very limited and potentially declining numbers, extent and/or habitat, making it vulnerable to global extinction or extirpation in the state. The sturgeon chub is one of several native minnows found in the large Eastern Montana prairie river drainages (Missouri, lower Yellowstone and Powder Rivers), and is an indicator species of the Large Mainstem Warmwater River Fish Assemblage that includes other big river species. (MNHP, 2007). Montana FWP personnel from Region 7 sampled fish weekly from mid-April through July 10, 2007 on the Tongue River. Observations of fish species did not include sturgeon chub in the

Tongue River (personal communication Mike Backes, Fisheries Technician FWP, Region 7).

The major threats to the sturgeon chub are thought to be habitat alteration by dam operations and irrigation operations and development. Chubs utilize riffles and runs in turbid shallow waters or deeper running waters. (American Fisheries Society, 1998). Due to limited distribution of the sturgeon chub in the Tongue River and since the dam removal is thought to be beneficial for this species, no adverse effects from dam removal are anticipated.

1.6.3.6.8 Sicklefin Chub (G3, S1)

The sicklefin chub is apparently one of the rarest fishes in Montana. It is native and was first collected in 1979. To date, the sicklefin chub has only been found at three sites (MNHP, 2007). Ranking in the state of Montana describes the sicklefin chub at high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to global extinction or extirpation in the state (MNHP, 2007). Distribution and habitat is similar to the sturgeon chub. The status of this fish is ranked globally as potentially at risk because of limited and potentially declining numbers, extent and/or habitat, even though it may be abundant in some areas (MNHP, 2007).

Montana FWP personnel from Region 7 sampled fish weekly from mid-April through July 10, 2007 on the Tongue River. Observations of fish species did not include sicklefin chub in the Tongue River (personal communication Mike Backes, Fisheries Technician FWP, Region 7). According to the American Fisheries Society, sicklefin chub is found in the lower Yellowstone River, from Intake Diversion Dam near Glendive to the confluence with the Missouri. Due to the distance from the SH Dam removal to known range of the sicklefin chub and the need for turbid waters, detrimental effects from dam removal are not anticipated.

1.6.3.6.9 Paddlefish (G4, S1, S2)

Dual state ranking lists paddlefish as at high risk because of extremely limited and potentially declining numbers, extent and/or habitat, making it highly vulnerable to global extinction or extirpation in the state (MNHP, 2007). Global ranking describes the paddlefish as uncommon but not rare (although it may be rare in parts of its range), and usually widespread. The paddlefish is apparently not vulnerable in most of its range, but possibly cause for long-term concern (MNHP, 2007).

Successful spawning seems to be the weak link in the paddlefish's survival. Paddlefish can grow well in reservoirs (even faster than in rivers), but they need natural, free-flowing rivers to reproduce effectively (American Fisheries Society, 1998). Sampling performed by Montana FWP personnel from Region 7 from mid-April through July 10, 2007 on the Tongue River did not include paddlefish. However, sampling techniques used would not necessarily be successful for paddlefish due to their size. Paddlefish could be using the Tongue River for spawning below the T&Y Dam (Personal communication Mike Backes, Fisheries Technician FWP, Region 7). One of the desired outcomes of the

Muggli Fish Passage feature and SH Dam removal is to allow paddlefish unimpeded access on the lower Tongue River. Since paddlefish require free flowing streams and turbid water for cover, effects of dam removal are unlikely to negatively impact the paddlefish.

1.6.3.7 Community Impact (Issue 11)

Overall community impacts are anticipated to be minimal since there are few residents in the vicinity. Downstream water users may have increased sedimentation in withdrawal infrastructure.

1.6.3.8 Aesthetics (Issue 12)

Returning the Tongue River to a natural condition and look will increase aesthetic functions following dam removal and vegetation establishment.

1.6.3.9 Recreation (Issue 13)

The removal of the SH Dam will likely enhance recreation opportunities through fish habitat restoration and fishing opportunities. Boating through the area will be easier for floaters who will not have to portage around the dam.

1.6.3.10 Cultural Resources (Issue 14)

In a letter dated January 16, 2008, the State Historic Preservation Office stated that the project will not affect any eligible properties.

1.7 Applicable Permits Licenses, and Other Consultation Requirements

1.7.1 Permits

1.7.1.1 Section 404 of the Clean Water Act

The US Army Corps of Engineers (USACE) has the authority to regulate wetlands and other "Waters of the US" under Section 404 of the Clean Water Act (CWA). A permit is required for filling, excavation in conjunction with filling, or otherwise disturbing existing jurisdictional Waters of the US. The USACE also regulates work and the placement of structures in navigable waters of the United States under Sections 9 and 10 of the Rivers and Harbors Act of 1899 (RHA). As part of the SH Dam project, an application will be made to the Montana Regulatory Office with removal plans and anticipated impacts to wetland vegetation and work in the Tongue River channel.

1.7.1.2 Montana Stream Protection Act (SPA 124)

The Montana Division of Fish, Wildlife and Parks (FWP) administers permitting for any project including the construction of new facilities or the modification, operation and maintenance of an existing facility that may affect the natural existing shape and form of any stream or its banks or tributaries. This permit is applicable to any federal, state or local government who proposes work as outlined above. Since removal of the SH Dam is being funded by the State of Montana, a permit application will be submitted to FWP Region 7.

1.7.2 Licenses/Entitlements

No known access agreements or entitlements are anticipated at this time some disposal options may require landowner access agreements.

1.7.3 Coordination Requirements

Some coordination with the operators of the Tongue River Reservoir may be beneficial for flow management and will be addressed in the construction documents.

2.0 ALTERNATIVES INCLUDING THE PROPOSED ACTION

2.1 Introduction

Four alternatives were identified. These include a no action alternative and three dam removal alternatives. The three dam removal alternatives have in common the removal of the existing diversion dam structure. They differ in the means by which the existing impounded sediment is removed or released from the impoundment. This section provides a description of the alternatives, estimated costs for implementation and a proposed action.

2.2 Common Attributes of the Action Alternatives

2.2.1 Remove Dam

All action alternatives involve removal of the main dam structure. The portion of the structure that would be removed consists of the concrete dam and footer spanning the river channel. The dam consists of approximately 500 cubic yards of concrete material (based on a width of 300 feet, a height of 6 feet and a trapezoidal cross-section that ranges from 3 to 10 feet wide at the top and bottom, respectively). The dam footer may consist of another 500 cubic yards of material, although this quantity is difficult to estimate as the dam and impoundment obscure the footer.

It is not known if an older, wooden crib dam exists upstream of the existing structure. It is not uncommon for such an older structure to be left in place when a larger or more permanent structure is constructed immediately downstream. A wooden crib structure apparently served as a dam until the 1930s, when the current concrete structure was installed (Confluence, 2007).

The abutments on the right (south) and left (north) bank would be left intact. The abutment on the left (north) bank is immediately adjacent to the river margin, whereas the abutment on the right (south) bank is set back from the average riverbank margin 20 to 50 feet (downstream to upstream). The left (north) bank abutment consists of approximately 70 cubic yards of concrete (8 to 14 feet high and about 75 feet long). The right (south) abutment is about 140 feet long and consists of both concrete (approximately 100–120 cubic yards) and stacked rocks (approximately 20–30 cubic yards) at the upstream end.

Concrete pieces of the dam structure would be placed in the existing diversion ditch to the north of the dam. Assuming a disposal rate of 6 cubic yards of concrete per lineal foot of ditch and 1,000 cubic yards of concrete requiring disposal, a few hundred feet of ditch would be filled. The concrete would be covered with sediment removed from the impoundment. Approximately 1,500 cubic yards of sediment would be required for this purpose. The area would be graded to match the adjacent topography and revegetated

with grasses. The metal headgate would be removed for subsequent use by the landowner.

Photo 3: Diversion ditch with diversion structure in background taken 9/21/07.

2.2.2 Fill Scoured Area South of Structure with Sediment Removed from the Impoundment

A segment of the south riverbank has been scoured upstream and downstream from the dam, resulting in a channel width up to 100 feet wider than the adjacent river.

This widened area consists of about 0.24 and 0.07 acres downstream and upstream from the dam, respectively. Sediment would be removed from the impoundment to fill this section of the south riverbank. The area would be filled with approximately 1,500 to 2,000 cubic yards of sediment. Approximately 200 to 250 feet of streambank would be reconstructed along the margin of the filled material.

Photo 4: SH Dam View South toward scour area Taken 9/21/07.

2.3 Description of Alternatives

2.3.1 Alternative 1 No Action – Leave Dam in Place

Alternative 1 involves taking no action. Under this alternative, the SH Dam, wingwalls and headgate would remain in place.

2.3.2 Alternative 2 Dam and Sediment Removal

Alternative 2 involves removing the dam structure and physically removing much of the sediment that has collected upstream of the dam. All of the accumulated sediment would not be removed; rather, the amount of sediment removed would be based on leaving a corridor comparable to the average dimensions of the non-impounded river channel. The amount of sediment that would be physically removed would be approximately 42,000 cubic yards.

The impounded sediment would be removed and transported using heavy equipment. Such equipment would likely include excavators and trucks or dozers and scrapers. Temporary haul roads would likely need to be constructed into the impoundment area; these would be removed upon completion of the sediment excavation. Conversely, a floating suction dredge (such as a Mud Cat™) with a pump line to the former diversion ditch could be used for material excavation and disposal.

Sediment removed from the impoundment would likely be placed in locations adjacent to the impoundment. These probable disposal areas include:

- The scoured area, described previously, could accommodate 1,500 to 2,000 cubic yards of sediment.
- The diversion ditch could accommodate about 800 to 1,000 cubic yards per 100 lineal feet. About 3,000 to 3,500 feet of ditch could be filled with 30,000 cubic yards of sediment. This length of ditch exists between the diversion and the first farm road that crosses the ditch.
- A triangle-shaped parcel located immediately south of the dam and east of the berm, 1.5 to 2.0 acres in size, where about 10,000 cubic yards of sediment could be placed.
- Yet another parcel of land located just further south and still east of the berm, also 1.5 to 2.0 acres in size, where 5,000 to 8,000 cubic yards of sediment could be placed.

Dam and sediment removal could occur at any time during the year when equipment access would not be restricted by high flow in the river.

2.3.3 Alternative 3 Dam Removal and Downstream Release of Sediments

Alternative 3 involves releasing impounded sediments into the river downstream of the dam as the dam is breached and eventually removed. Alternative 3A would release the sediment during a single season. Alternative 3B would release the sediments in two or more stages (multi-year) as the dam is incrementally removed.

Sediments would be carried downstream by the flow in the river. The rate and the distance downstream that sediment would be transported would depend on the flow characteristics following dam removal. For a discussion of the estimated rate of sediment transport and the potential downstream effects of released sediment, see the description of this topic under *Section 3 Affected Environment*.

2.3.3.1 Alternative 3A Single-Season Dam Removal and Release of Sediments

Alternative 3A involves removal of the dam and the subsequent unregulated downstream release of the impounded sediment. The sediment would be carried downstream by flow; the rate and distance that the sediment would depend on the flows that occur over the subsequent years.

2.3.3.2 Alternative 3B Staged Dam Removal and Release of Sediments

Alternative 3B involves the incremental removal of the dam in stages of two or more years. A staged removal would be undertaken to provide regulation of the downstream release of impounded sediment. Several different staging scenarios could be employed. For example, a simple approach would be to remove the dam to half its present height during one period and the remaining half during the second period (a period can be defined as one year, or periods can be considered as pre- and post-runoff seasons). This approach could be applied over several periods, or over alternating periods, depending on the objectives for managing the downstream dispersal of sediment. For the purpose of estimating the costs and environmental effects associated with a staged dam removal, a two-stage removal over two years was assumed.

2.3.4 Alternative 4 Dam Removal and Partial Sediment Removal and Partial Downstream Release

Alternative 4 involves a combination of partial sediment removal (parts of Alternative 2) and partial downstream release of sediments (parts of Alternative 3). Some sediment would be removed from the impoundment prior to or soon after breaching the dam, while additional sediment would be released downstream. The amount of sediment removed and released would depend on the reasons for selecting this alternative. One reason might include the desire to reduce the amount of sediment released downstream, either in total or after an initial (but incomplete) release of sediment downstream.

2.4 Implementation Methods

Control of Water

Implementation of the action alternatives would necessitate some need to control water. Under Alternatives 2 and 4, removal of impounded sediment using conventional earthmoving equipment would require employing methods of diverting flowing water from portions of the work site. Temporary coffer dams might be constructed of riverbed gravel or may use a physical barrier, such as AquaDam®, a series of water-filled rubber bladders. Under Alternatives 2 and 4, a dewatering system that involves pumping standing water might also be required. Conversely, if a suction dredge were used, control of water would likely not be required. Control of water under Alternative 3 would be limited to that required to provide equipment access for dam structure removal. Depending on the flows during construction and the approach, no water control may be required.

Erosion Control

Erosion control measures will be employed to minimize the release of sediment from disturbed areas (outside of the river channel). These areas include concrete disposal locations, sediment disposal sites (if used), and temporary access roads. Erosion control measures might include silt fence and reconstruction of disturbed riverbanks using bioengineered bank stabilization measures.

2.5 Estimated Costs for Implementation

The legislature of the State of Montana allocated funds in 2007 to remove the SH Dam. Other monies may be available if these allocated funds are inadequate to fully implement the project. Approximately $270,000 is available through the legislature and additional resources may be available through Fish, Wildlife and Parks if needed. The costs for dam removal range from approximately $150,000 (Alternative 3A) to $650,000 (Alternative 2). Table 1 provides a summary of estimated costs associated with project alternatives as well as a summary for objectives attainment. A detailed engineering cost estimate is included as Appendix A.

Table 1 Comparison of Alternatives

Alternative	Provide Fish Passage	Estimated Costs	Available Funding?
Proposed Action Alternative 3A Single-Season Dam Removal and Release of Sediments	Dam removal and downstream release of sediments will meet the primary objective of fish barrier removal	$149,483.	Yes
Alternative 1 No Action – Leave Dam in Place	Leaving the dam in place will not meet the main objective of providing unimpeded fish passage	$0	Yes-no construction budget required
Alternative 2 Dam and Sediment Removal	Removal of dam and sediments will meet the primary objective of fish barrier removal.	$657,706.	No – Additional funding sources required
Alternative 3B Staged Dam Removal and Release of Sediments	Dam removal and downstream release of sediments will meet the primary objective of fish barrier removal	$174,962.	Yes
Alternative 4 Dam Removal and Partial Sediment Removal and Partial Downstream Release	Dam removal and partial downstream release of sediments will meet the primary objective of fish barrier removal	$426,421.	No – Additional funding sources required

2.6 Proposed Action

The proposed action is Alternative 3A, which involves dam removal and the non-staged downstream release of sediment. Alternative 3A meets the goals and objectives of dam removal project. The adverse environmental consequences of the downstream sediment release appear to be minimal and/or short term. Alternative 3A is also the lowest cost action alternative to implement.

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

This section outlines existing conditions related to the Tongue River and surrounding resources as background documentation and does not include effects of proposed alternatives. Resources include irrigation water, groundwater, Tongue River water quality, river morphology, fisheries and vegetation. The water quality section relies primarily on the recent final draft report published by the Montana Operations Office, US EPA on August 2, 2007 entitled "Water Quality Assessment for the Tongue River Watershed, Montana." Section 3.4 discusses some cumulative effects from multiple sources associated with the alternatives.

3.2 Description of Relevant Affected Resources

3.2.1 Surface Water Resources

The primary surface water uses associated with the Tongue River include irrigation, fish and wildlife, and recreation. Due to increased use of sprinkler irrigation and direct/adjacent pumping withdrawals from the Tongue River, the SH Canal was abandoned in the 1990s by sealing headgates and welding them shut (Confluence, 2007).

3.2.2 Ground Water Resources

Available records indicate that groundwater development in the area is primarily for stockwater use with wells completed in sedimentary formations typical of the area (Montana Bureau of Mines and Geology, 1998-2007). Well depths range from 100 feet to 590 feet with highest static water at 70 feet below ground surface. Although there is no available well log data in the vicinity, there is likely artificially high groundwater elevation localized near the SH Dam.

3.2.3 Water Quality

A water quality report for the Tongue River was recently completed by the U.S. Environmental Protection Agency Montana Operations Office and Tetra Tech, Inc. Pollutants addressed included salinity, sodium adsorption ratio (SAR), metals, sulfates, sediment, nutrients, dissolved oxygen, and temperature. In 1996, Montana DEQ included four segments of the Tongue River on the 303(d) list of impaired waters: Tongue River from the Wyoming border to the Tongue River Reservoir; Tongue River from the Tongue River Reservoir Dam to the confluence with Hanging Woman Creek; Tongue River from the confluence with Hanging Woman Creek to the T&Y Dam; and Tongue River from the dam to the mouth. However, the basis for the 1996 listings is unknown. A revised listing for each segment appeared on Montana's 2006 303(d) list, and only the Tongue River from the T&Y Dam to the mouth was listed as impaired, and only due to flow alterations (US EPA, 2007). Data for the Tongue River are available from the late 1950s to the present, and include both grab and continuous samples. Grab samples are available from over 100 stations in the Tongue River in Montana and Wyoming, dating from 1959 to 2006, and collected by multiple governmental agencies and private organizations (US

EPA, 2007). The USGS also has continuous monitoring data for seven stations in Wyoming and Montana.

3.2.3.1 Salinity

The primary measure of salinity is specific conductance (SC), with units of microSiemens per centimeter (μS/cm). SC The largest increase in mean salinity per river mile occurs between Dayton, Wyoming and Monarch, Wyoming, where there is an average increase of 7.0 μS/cm per river mile (US EPA, 2007). The increase in average salinity per river mile is relatively low downstream of the Tongue River Reservoir, with a maximum increase of 1.8 μS/cm occurring between the Birney Day School Bridge and the Brandenberg Bridge (US EPA, 2007). The monthly average salinity standards for the Tongue River are 1,000 μS/cm for the growing season and 1,500 μS/cm for the non-growing season. Exceedances have only been observed at two locations; the Tongue River at the Birney Day School Bridge – USGS Gage 06307616, and the Tongue River at Miles City – USGS Gage 06308500. All of the exceedances occurred during low flow conditions (i.e., < 20^{th} flow percentile) and during the growing season (US EPA, 2007).

3.2.3.2 Sodium Adsorption Ratio (SAR)

The sodium adsorption ratio (SAR) is the ratio of sodium to calcium plus magnesium concentrations expressed as milliequivalents. The monthly average SAR standards for the Tongue River are 3.0 for the growing season and 5.0 for the non-growing season. The instantaneous maximum SAR criteria for the mainstem Tongue River are 4.5 for the growing season and 7.5 for the non-growing season. None of the available SAR data for the mainstem Tongue River has ever exceeded these criteria (US EPA, 2007). In the past 5 years, no exceedances of the average monthly criteria have been observed. It should be noted, however, that data are limited for the non-growing season at all stations except the Tongue River at the Montana/Wyoming State Line – USGS Gage 06306300. The ability to reach conclusions about SAR during the non-growing season, therefore, may be restricted by limited data (US EPA, 2007).

3.2.3.3 Metals

The Montana 1996 303(d) list included impairment for aquatic life and fishery beneficial uses in the segment of Tongue River from the confluence with Hanging Woman Creek to the mouth due to metals. No specific metals are listed, but the 1996 list applies to one or more of the constituents: arsenic, cadmium, chromium, copper, iron, lead, nickel, selenium, silver and zinc (US EPA, 2007). Metals were not listed as a cause of impairment on the 2006 303(d) list. Data gathered between March 27, 2002 and May 16, 2006 from eight stations between the Tongue River Dam and the T&Y indicate periodic exceedances of iron above the 1,000 μg/L standard. The Tongue River has a naturally high sediment load. Metals are bound to sediment in varying degrees, depending on the local geology and sources. Both total recoverable and total metals laboratory analyses measure the sediment-bound metals in the sample, in addition to the dissolved water column metals. Therefore, when a water sample has more sediment, it is likely that the total or total recoverable metals sample will have higher metals concentrations (US EPA, 2007). This is significant because it is primarily the dissolved form that causes aquatic toxicity, and USEPA has recommended that criteria for metals be re-expressed as dissolved concentrations.

3.2.3.4 Total Suspended Solids

The Tongue River from the confluence with Hanging Woman Creek to the mouth was listed on the Montana 1996 303(d) list as impaired because of suspended solids (MDEQ, 1996). Suspended solids were not listed as a cause of impairment on the 2006 303(d) list. Compared to rivers in some other parts of the country, the Tongue River has naturally high suspended solids due to soils, geology and topography (US EPA, 2007). Historic accounts (early 1800s) state that the Tongue River was very muddy and shallow, with shifting sand bars and quicksand present in the channel near Miles City (US EPA, 2007). Many warm water fish species including several species of fish found in the Tongue River are adapted to the high turbidity waters (e.g., paddlefish, sturgeon chub and sauger).

3.2.4 River Morphology

Table 2 includes data collected by the USGS as part of the report *Channel-Morphology Data for the Tongue River and Selected Tributaries*, *Southeastern Montana*, *2001-02* (USGS, 2004). A discussion of assumptions, data limitations and methods are listed in the report. The Brandenberg Bridge is the closest station to the SH Dam that may be used for reference. Survey data was gathered in the vicinity of the SH Dam associated with SH Dam Conceptual Design Report. However, data gathered is limited to existing up- and downstream conditions of the river in relation to effects from the diversion structure. Likewise, the use of Brandenberg Bridge data as background may be limited by factors including distance from the project site and location of survey related to potential effects of the bridge. Downstream data is limited due to the distance from the project site and significant increase of watershed drainage area at the Miles City site.

Table 2 Tongue River Morphological Data From USGS, 2004

Site ID (USGS)	Width/ depth ratio (foot per foot)	Bankfull water-surface slope (foot per foot)	Entrench-ment ratio (foot per foot)	Sinuosity (foot per foot)	Bankfull discharge (cubic feet per second)	Bankfull-recurrence interval (years)	Rosgen channel type	Predomi-nant streambed material
State Line 06306300	35	0.001	2.800	1.6	1,950	1.3	C6c	Silt/clay
Tongue River Dam 06307500	37	.002	3.100	1.3	1,500	1.3	C3	Cobble
Birney Day School Bridge 06307616	33	.001	1.600	1.6	975	1.1	C6c	Silt/clay
Brandenberg Bridge 06307830	30	.002	1.100	1.8	1,270	1.4	F4	Gravel
Miles City 06308500	39	.001	1.400	1.8	1,640	1.2	C4c	Gravel

3.2.5 Fisheries

As stated in previous sections, there will be benefits to the warm water fishery resulting from dam removal, especially for migrating species. The Tongue River Dam acts as a sediment trap, impounding sediments that would be available for transport and cover for migrating species. The Powder River shares many of the species with the Tongue River, represents the pre-dam status of a Great Plains river, supports its entire native fish assemblage and has total suspended sediment concentrations markedly greater than the Tongue River. Median values of total suspended sediment measured at a USGS gage on the Powder River (Station 06324500) are over an order of magnitude greater than those measured on the Tongue River (Station 06308500) (Confluence, 2007). Non-native fish species (e.g., brown trout and northern pike) less tolerant to sediment also inhabit the Tongue River and may be negatively affected by removal of the SH Dam. However, presence of these species is primarily incidental and effects will likely be short term. Conversely, undesirable non-native species such as the sunfish will likely benefit from dam removal and compete with native species (personal communication on December 20, 2007 with Mike Backes, Fisheries Technician, Region 7 FWP).

3.2.6 Terrestrial Vegetation

The NRCS Phase II Stream Corridor Assessment found that the dominant plant communities along the main stem of the Tongue River are eastern cottonwood, green ash, boxelder maple and peachleaf willows in the overstory, and western snowberry, red osier dogwood, chokecherry and wild rose in the understory (NRCS, 2002). These plant communities were found in varying combinations throughout the floodplains of the Tongue River, Hanging Woman Creek, Pumpkin Creek and Otter Creek. Noxious species, including leafy spurge, Canada thistle, Russian olive and salt cedar, were also observed. NRCS noted that these invasive species appear to be increasing throughout the watershed (NRCS, 2002).

3.3 Description of Relevant Pre-Existing Factors

3.3.1 Impoundment Above Dam

Based on cross-sections in the Conceptual Design Report, the area of impoundment is approximately, 11 acres with an average width of 174 feet (range of 160 feet to 190 feet). The estimated river channel width in a natural state would be approximately 120 feet to 160 feet. The volume of impounded sediment (in excess of estimated natural state) behind the dam was estimated at 41,600 cubic yards (Conceptual Design Report). Another estimate of impounded sediment was calculated using the cross-sections from the Confluence report and the average end-area method. Approximately 42,000 cubic yards of impounded sediment was calculated by this method. Laboratory results indicate that the sample collected for grain-size distribution contained 3% fines (finer than the 200 sieve), 73% sand and 24% gravel (Confluence, Inc., 2007).

Sampling and analytical laboratory testing for impounded sediments was completed as part of the conceptual design. One composite sample was derived from eight sediment samples collected upstream within 100 feet of the dam and analyzed for corrosivity, total metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium, silver), chlorinated herbicides, organochlorine herbicides and polychlorinated biphenyls (PCBs). One centrally located sample was collected and analyzed for volatile organic compounds (VOCs). Screening results for the constituents analyzed were all below laboratory detection limits with the exception of barium (69mg/kg) (Confluence, Inc., 2007). Barium is a naturally occurring substance and may be found in higher concentrations in coal beds, which are present in the Tongue River drainage (Confluence, Inc., 2007). The background concentration of barium listed in Montana is 739 mg/kg and the US EPA Region 9 Preliminary Remediation Goal (PRG) Table for soils lists the PRGs for barium in residential soils as 5,400 mg/kg.

Bank vegetation composition in the area is dependent on topographic position in relation to river morphology and impounded water. The diversion structure has created backwater and accumulated sediments that are favorable to establishment of a somewhat wider wetland fringe than would be supported in a free-flowing state. In a natural state, there is more abundance and diversity on inside bend point bars and terraces due to more area of favorable soil and moisture regimes than on outside bends where lateral river migration results in steeper banks and a relatively narrow wetland fringe. Existing vegetation adjacent to the banks of the river consists of cattail (Typha latifolia), Nebraska sedge

Photo 5: Impoundment Area View Upstream Taken 11/26/07

(Carex nebrascensis) and other sedges, and sandbar willow (Salix exigua) (Confluence, Inc., 2007). Also according to the Conceptual Design Report, upland areas include Japanese brome (Bromus japanicus), big sage (Artemesia tridentata), Wood's rose (Rosa woodsii), red-osier dogwood (Cornus sericea) and cottonwood trees (Populus spp.)

3.3.3 Dam Immediate Area

The dam and canal system was privately owned and built. The original cribbed log dam was converted to concrete in the 1930s (Confluence, Inc., 2007). There are two concrete wing walls with relatively dense herbaceous and woody plant species on each end of the dam. The south wing wall has a date stamped into the concrete of 1914. The SH Canal originates at the north end of the dam where two large steel plates and headgates historically controlled flow. The canal has since been abandoned by welding the headgates shut. Sediment and wetland vegetation inhabit both sides of the headgate, and it appears that some water is seeping through the structure providing hydrology for wetland vegetation in the abandoned canal. There is also a log jam and vegetated gravel bar at the middle portion of the dam essentially splitting flow over the dam.

3.3.4 Downstream of Dam

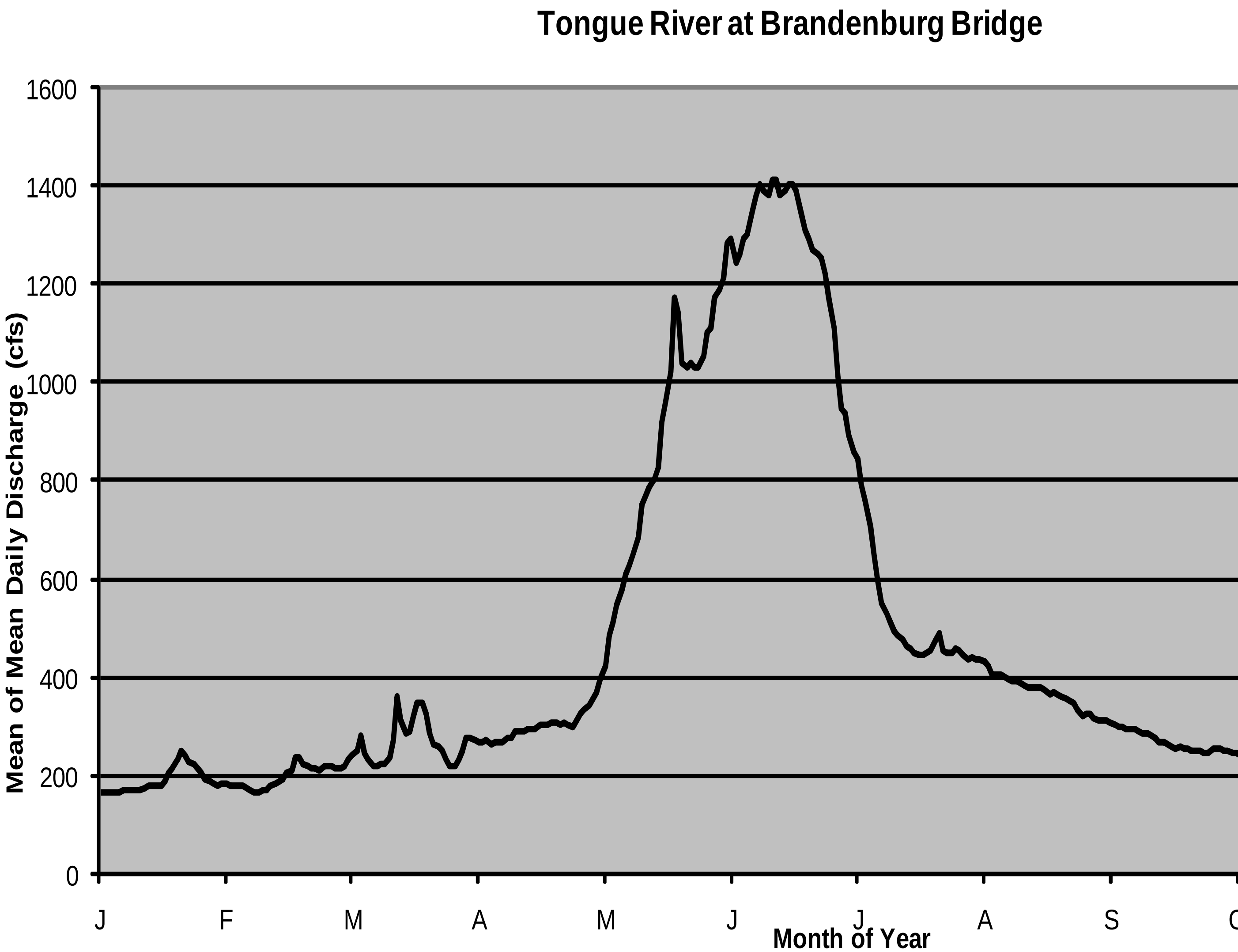
The river downstream of the dam has been incised relative to its natural morphology. There is a vegetated island corresponding with the log jam and bar at the dam. The north side of the river appears to have a high resistance to scour due to the presence of an exposed sandstone layer. There is a significant scour area at the south bank of the river immediately below the dam where high flow has eroded into river alluvium.

Photo 6: Area Below the SH Dam Taken 9/21/07

3.3.5 River Hydrology

The Tongue River is primarily controlled by the Tongue River Dam (river mile 203), located approximately 115 river miles upstream of the SH Dam (river mile 75). The US Geological Survey (USGS) maintains four gauging stations between the Tongue River Reservoir and Miles City. The nearest station is at Brandenberg bridge near Ashland, Montana (river mile 81), approximately six river miles upstream of the SH Dam. The daily mean flows are highest from May through July. Maximum flows are in June and are approximately 1,400-cubic feet per second (cfs). Low flows are generally from October through about mid-March and range from about 160 cfs to 250 cfs (USGS, 2004). Peak recorded stream flow for the period of record is 8,340 cfs, which corresponds closely to the 1% Annual Peak Discharge (100-year discharge) of 9,020 cfs as estimated by the USGS.

Figure 2: Mean daily hydrograph for Tongue River at Brandenberg Bridge (USGS 06307830)



3.4 Description of Areas Related to Cumulative Affects

This section outlines potential cumulative impacts that might result from multiple sources associated with the project. Potential cumulative impacts from other sources in the Tongue River drainage are addressed in Chapter 4.

3.4.1 Impoundment Area Above Dam

3.4.1.1 Alternative 1 No Action – Leave Dam in Place

This no action alternative would not change existing conditions and will continue to adversely affect some aspects of the river (primarily impeding fish passage).

3.4.1.2 Alternatives 2 through 4 Dam Removal with Sediment Management Options

In general, the removal of the diversion structure will result in restoration of natural biological, chemical and physical attributes of the river system. Cumulative effects of the dam removal with several sediment release/removal options will likely have similar effects on the impoundment area. All options will result in the conversion of the impoundment to a more natural river setting through changes in soil/sediment, moisture and vegetation relationships along the banks. However, short- term effects from dam removal will include the potential for weed establishment on remaining exposed sediments and nuisance dust. There is likely enough seed in the impounded sediments and from upstream sources that vegetation that will germinate under favorable conditions following dam removal, stabilizing soil and eventually replacing any pioneer weedy species. The existing wetland fringe will likely be converted to transitional or upland type vegetation.

Short-term impacts associated with sediment transport will depend primarily on seasonal flow events. For this Environmental Assessment, a sediment analysis was conducted. Results indicate that the total amount of sediment impounded behind the dam, approximately 42,000 cubic yards of sediment represents 25% to 42% of the annual natural bed load and 50% to 75% of the bed load cumulatively transported when average flows exceed 500 cfs (early May through mid-July). Therefore, the maximum amount of sediment potentially released during dam removal would be a significant fraction of the typical annual or seasonal bedload transported downstream. Appendix B provides a detailed discussion of the sediment transport analysis undertaken for this Environmental Assessment.

Previous studies of dam removal indicate that the erosion and transport of impounded sediment is not immediate upon structure removal, as the ultimate achievement of post-dam sediment transport equilibrium is related to the occurrence of high flows. Observations indicate that sediment delivery typically occurs as a series of pulses.

3.4.2 Dam Immediate Area

3.4.2.1 Alternative 1 No Action – Leave Dam in Place

This no action alternative would not change existing conditions and will continue to adversely affect some aspects of the river (primarily impeding fish passage).

3.4.2.2 Alternatives 2 through 4 Dam Removal with Sediment Management Options

In general, the removal of the diversion structure will result in restoration of natural biological, chemical and physical attributes of the river system. The physical removal of the dam structure will include machinery for demolition and transportation of concrete waste material and other debris. Under all removal options, wing walls would be left in place. The wing walls are adjacent to established woody vegetation. The north wingwall provides some level of bank stability; the south wingwall is not adjacent to the active river channel. The wing wall on the left bank appears to be located on exposed bedrock and will not likely contribute to long-term effects on river morphology.

3.4.3 Downstream of Dam

3.4.3.1 Alternative 1 No Action – Leave Dam in Place

This no action alternative would not change existing conditions and will continue to adversely affect some aspects of the river (primarily impeding fish passage).

3.4.2.2 Alternatives 2 through 4 Dam Removal with Sediment Management Options

The primary effects of dam removal on the river system below the diversion structure are the accumulation and redistribution of bed load and suspended sediments from release of impounded sediments, as well as long-term river system sediment and flow dynamics. Determination of effects from the different release options is difficult to qualify. The quantity and timing of sediment release was analyzed and is discussed in greater detail in Appendix B.

To estimate the potential downstream effects of released sediment impounded by the dam, the volume of the sediment was compared to the downstream river channel. If the 42,000 cubic yards of impounded sediment were deposited over lengths of 0.8, 1.6, and 3.3 river miles, the depth of accumulation would be approximately 2, 1, and 0.5 feet respectively. This geometric exercise seems reasonable given that the average impounded sediment depth over the estimated 0.64 mile length of impounded sediment was calculated to be 2.3 feet. However, empirical evidence from other low-head dam removals suggests that much of the sediment stored behind these dams will remain in place. Prior removal projects indicate that a new floodplain or terrace feature will form within the formerly impounded area following dam removal. This sediment is gradually eroded and transported as a consequence of long-term channel migration. Anticipated cumulative effects will generally include an increase in downstream river bar and island formation, which in turn will support riparian vegetation.

Downstream surface water users may be affected by increased sedimentation of irrigation withdrawal infrastructure. Two pump diversions are located within the first five miles downstream of the dam (Figure 2). The diversion locations were obtained from the Montana Natural Resource Information System (NRIS) website. The first pump location is approximately one mile below the dam and the second location is approximately three miles below the dam. Pump diversions float within the river and are typically removed from the river after the irrigation season is over. Further downstream (over five miles) there are permanent irrigation structures located within the river. Since empirical evidence from other low-head dam removal projects suggests that impounded sediment is transported episodically rather than as a single massive slug, it is anticipated that several miles downstream of the project site, the released material will be reworked with respect to grain size and spread as a relatively thin layer on the channel bed. Assuming that the pump diversions allow flexibility with regard to the timing and location of their use, no adverse effects to irrigation facilities are expected from the Proposed Action. The transported sediment mass profile is expected to decay both spatially with distance downstream of the dam and temporally over the course of several years. A small irrigation facilities maintenance budget has been included in the cost estimate of the Proposed Action; the maintenance would include monitoring impacts and addressing accumulated sediments at irrigation withdrawal sites.

4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

Chapter 4 provides information to evaluate alternatives in relation to project objectives, effects on relevant resources, and unavoidable adverse effects.

4.2 Predicted Attainment of Project Objectives of All Alternatives

4.2.1 Predicted Attainment of Fish Barrier Removal

4.2.1.1 Alternative 1 Leave Dam in Place - No Action

Leaving the dam in place will not meet the main objective of providing unimpeded fish passage for species of concern.

4.2.1.2 Alternative 2 Dam and Sediment Removal

The mechanical removal of dam and sediments will meet the primary objective of fish barrier removal.

4.2.1.3 Alternative 3A and 3B Dam Removal and Downstream Release of Sediments

The mechanical removal of the dam and downstream release of sediments will meet the primary objective of fish barrier removal.

4.2.1.4 Alternative 4 Dam Removal with Sediment Removal and Partial Downstream Release of Sediments

The mechanical removal of the dam and partial downstream release of sediments will meet the primary objective of fish barrier removal.

4.2.2 Predicted Attainment of Project Budget

4.2.2.1 Alternative 1 No Action

This alternative would not result in expenditures for construction aspects of dam removal. Costs incurred would be limited to research, analysis and design of removal alternatives.

4.2.2.2 Alternative 2 Dam and Sediment Removal

As outlined in the engineering cost estimate (Table 1in Section 2.5 and Appendix A) the approximate cost for Alternative 2 is $658,000. Limited funding makes this option challenging since this estimate significantly exceeds monies allotted by the 2007 Montana Legislature.

4.2.2.3 Alternative 3A and 3B Dam Removal and Downstream Release of Sediments

As outlined in the engineering cost estimate (Table 1 in Section 2.5 and Appendix A) the approximate costs for Alternative 3A and 3B are $150,000 and $175,000, respectively. Both of these alternatives would meet project budget constraints. A decision based on cost will require balancing any advantages of Alternative 3B over 3A.

4.2.2.4 Alternative 4 Partial Sediment Removal and Partial Downstream Release

As outlined in the engineering cost estimate (Table 1 in Section 2.5 and Appendix A) the approximate cost for Alternative 4 is $426,000. Limited funding makes this option challenging since this estimate significantly exceeds monies allotted by the 2007 Montana Legislature.

4.3 Predicted Effects on Relevant Affected Resources of All Alternatives

4.3.1 Issue 1 Surface and Ground Water Resources

4.3.1.1 Effects of Alternative 1 No Action on Surface and Ground Water Resources

The no action alternative would not change general surface or groundwater conditions associated with the dam.

4.3.1.2 Effects of Alternatives 2 through 4 Dam and Sediment Removal Options on Surface and Ground Water Resources

- **Direct Effects**

  Effects from the dam removal will lower the impounded surface water elevation up to about 6 feet at the dam location, with progressively less effect extending upstream 3,000 feet to where there would be no change in water elevation. The localized groundwater surface affected by the impoundment will likely drop several feet near the dam. Dam removal would not likely have much of an effect on groundwater elevation moving away from the dam, assuming a relatively high hydraulic conductivity of river alluvium.

- **Indirect Effects**

  Restoring the immediate surface and groundwater elevation will result in transition of aquatic and terrestrial flora and fauna immediately surrounding the impoundment. Aquatic and transitional species of plants would likely establish on river bars and banks in depositional portions of the stream and decrease on outside bends and areas actively eroded by the river. This active channel would likely increase stream functions associated with nutrient and sediment flux and subsequent river system food chain support. The amount of sediment released downstream as part of the dam removal will likely have an effect on the amount of aquatic flora and fauna that rely on those sediments as they are deposited downstream. Sediment release will likely affect the maintenance of downstream diversion and direct withdrawal infrastructure at varying degrees based on the amount of sediment released and, location (within the channel and distance from the SH Dam) and type of diversion structure.

- **Cumulative Effects**

No cumulative effects outside of natural seasonal fluctuations are anticipated.

4.3.2 Issue 3 Water Quality

4.3.2.1 Effects of Alternative 1 No Action on Water Quality

Under Alternative 1 there would be no change in existing water quality conditions, and the area would continue to function as it has with water quality fluctuating during high flow events.

4.3.2.2 Effects of Alternative 2 through 4 Dam and Sediment Removal Options on Water Quality

- **Direct Effects**

All removal options will include some downstream release of sediments that will directly affect water quality. (Alternative 2 includes incidental sediment release associated with construction operations). As outlined in Section 3.2.3 and 3.3.1, impounded sediments appear to have naturally occurring levels of inorganic and organic compounds generally below detectable levels. Sediment release could result in fish mortality for some mainly non-native species with lower turbidity thresholds than native species adapted to turbid waters, depending on sediment release concentrations related to river flow.

- **Indirect Effects**

Anticipated indirect effects will generally include a change in channel morphological characteristics affecting the riverine ecosystem, resulting in an increase of river bar and island formation. Bars and islands will provide growth media for terrestrial vegetation that in turn provides nutrient storage and cycling.

- **Cumulative Effects**

No known planned release of sediments from other projects affecting the area is known at this time. Future effects from removal of the upstream Mobley Dam could contribute to sediment release in the Tongue River. However, removal of the Mobley Dam is under negotiation and the outcome is not certain at this time.

4.3.3 Issue 5 Vegetation/Wetlands

4.3.3.1 Effects of Alternative 1 No Action on Vegetation/ Wetlands

Under the no action alternative there would be no change on wetland vegetation and the area would continue to function as it has in the recent past.

4.3.3.2 Effects of Alternatives 2 through 4 Dam and Sediment Removal options on Vegetation/ Wetlands

- **Direct Effects**

All removal options will include lowering water elevation that will directly affect impoundment fringe wetland through the gradual conversion to transitional or upland plant species. These effects will be less evident further upstream of the dam where water elevation changes will be less evident. The wetland fringe will become established along the riverbanks once the area has stabilized. Wetland continuity will adapt and replace the existing lacustrine fringe with a typical riverine wetland fringe.

- **Indirect Effects**

Removal options will return sediment transport continuity to the river system that will likely result in plant growth media through the formation of bars and islands below the dam, where the river is somewhat incised. This incised area will reach equilibrium with the river system providing opportunities for plant growth, regardless of sediment removal options. Downstream release of sediment will increase plant establishment over time. The amount of sediment released will affect the amount of growth media available. Over time, these sediments will continue to be transported downstream; this should result in an increase of plant growth as long as these sediments remain in the system.

- **Cumulative Effects**

No significant cumulative effects are anticipated outside of ongoing agricultural practices that could have some minimal effect on wetland vegetation.

4.4 Unavoidable Adverse Impacts (on all resources)

4.4.1 Unavoidable Adverse Impacts on Surface and Groundwater

All removal alternatives will lower stable surface and groundwater in the immediate area that will affect plant-moisture relationships. Fluctuating water elevations will replace the relatively stable controlled system triggering more seasonal plant-moisture relationships and the availability of moisture to plants. Lowering of groundwater in the area could affect production of adjacent developed wells. Available data indicate that groundwater is relatively deep (greater than 150 feet). However, no data were available for wells adjacent the project area. These wells could be affected by less river-induced recharge of groundwater.

4.4.2 Unavoidable Adverse Impacts on Water Quality

All removal alternatives will increase turbidity in the river system. Short-term and localized impacts associated primarily with turbidity are possible during construction and changes in river flow. Construction impacts are anticipated to be minimal through timing of construction. Flow events will dictate how and when sediment will be transported.

4.4.3 Unavoidable Adverse Impacts on Vegetation/ Wetlands

As outlined in section 4.3.3.2, much of the existing wetland vegetation will adapt to drier conditions and convert to upland or transitional species of plants. There is also wetland vegetation in the diversion ditch. The diversion ditch wetland will be lost by filling with concrete rubble and sediment from the dam. Wetland vegetation may be salvaged prior to placement of waste material in the ditch. Salvaged wetland sod could be utilized to stabilize areas with sufficient moisture as part of construction reclamation.

Table 3 Comparison of Environmental Consequences

Alternatives	Proposed Action Alternative 3A Single-Season Dam Removal and Release of Sediments	Alternative 1 No Action – Leave Dam in Place	Alternative 2 Dam and Sediment Removal	Alternative 3B Staged Dam Removal and Release of Sediments	Alternative 4 Dam Removal and Partial Sediment Removal and Partial Downstream Release
Surface and Groundwater Resources	Increase short term siltation of irrigation diversions downstream	No change in current condition	Limited short term siltation of irrigation diversions downstream	Increase short term siltation of irrigation diversions downstream	Increase short term siltation of irrigation diversions downstream
Soil/Land Resources	No long term impacts	No change in current condition	No long term impacts	No long term impacts	No long term impacts
Air Quality	No Long term impacts	No change in current condition	No long term impacts	No long term impacts	No long term impacts
Water Quality	Short and medium range increase in turbidity	No change in current condition	Minor short term increase in turbidity	Minor short term increase in turbidity	Minor short and medium range increase in turbidity
Vegetation/ Wetlands	No net loss and potential downstream gain	No change in current condition	No net loss and potential downstream gain	No net loss and potential downstream gain	No net loss and potential downstream gain
Weeds	Short term increase	No change in current condition	Short term increase	Short term increase	Short term increase
Fisheries	Will increase fish mobility and spawning habitat	Habitat fragmentation and fish exclusion continues	Will increase fish mobility and spawning habitat	Will increase fish mobility and spawning habitat	Will increase fish mobility and spawning habitat
Wildlife	No long term affects	No change in current condition	No long term affects	No long term affects	No long term affects
Threatened/ Species of Special Concern	Will promote passage and spawning habitat	Habitat fragmentation and fish exclusion continues	Will promote passage and spawning habitat	Will promote passage and spawning habitat	Will promote passage and spawning habitat
Community Impact	Local residents in-favor of project	No change in current condition	Local residents in-favor of project	Local residents in-favor of project	Local residents in-favor of project
Aesthetics	Increase natural river functions	No change in current condition	Increase natural river functions	Increase natural river functions	Increase natural river functions

Alternatives	Proposed Action Alternative 3A Single-Season Dam Removal and Release of Sediments	Alternative 1 No Action – Leave Dam in Place	Alternative 2 Dam and Sediment Removal	Alternative 3B Staged Dam Removal and Release of Sediments	Alternative 4 Dam Removal and Partial Sediment Removal and Partial Downstream Release
Recreation	Increase fishing, boating	Continued portage for boaters, no change in fishing	Increase fishing, boating	Increase fishing, boating	Increase fishing, boating
Cultural Resources	No significant impact, dam not eligible for listing	No change in current condition	No significant impact, dam not eligible for listing	No significant impact, dam not eligible for listing	No significant impact, dam not eligible for listing
Public Controversy	Limited involvement to date response from nearby residents positive	No change in current condition	Limited involvement to date response from nearby residents positive	Limited involvement to date response from nearby residents positive	Limited involvement to date response from nearby residents positive

5.0 PUBLIC PARTICIPATION

According to Brad Schmitz, little public comment is anticipated due to limited public use and interest in the area. Adjacent landowners have been involved through communication with FWP personnel and as part of the Conceptual Plan. However, the public will be encouraged to comment on the draft EA through:

- Legal notices published in local and regional newspaper publication(s) including the Billing Gazette, Miles City Star.
- Legal notice and posting of draft EA on the FWP website: http://fwp.mt.gov/publicnotices.
- Direct notice to adjacent landowners and downstream water users within 5 miles.
- The draft EA will be available at the Region 7 Headquarters in Miles City and the FWP State Headquarters in Helena.

The public comment period will be 30 days. This public comment period will begin on March 25, 2008 and run through April 25, 2008. Written comments may be emailed to brschmitz@mt.gov, or sent to the following address:

Brad Schmitz
Regional Fisheries Manager
FWP, Region 7
P.O. Box 1630,
Industrial Site West,
Miles City MT 59301
406-234-0914

6.0 People Associated with the Project

List of preparers:

Ron Orton	Allied Engineering Services, Inc.
Paul Sanford, PE	Allied Engineering Services, Inc.
Dale Miller	Mainstream Restoration, Inc
Karin Boyd	Applied Geomorphology, Inc.

List of Internal Reviewers:

Brad Schmitz	Montana Fish, Wildlife and Parks, Region 7
Paul Valle	Montana Fish, Wildlife and Parks, Design and Construction Bureau
Kevin McDonnell	Montana Fish, Wildlife and Parks, Design and Construction Bureau
Rebecca Cooper	Montana Fish, Wildlife and Parks, Headqaurters
Glenn Phillips	Montana Fish, Wildlife and Parks, Habitat Protection Bureau

7.0 REFERENCES

American Fisheries Society. (1998, June). Retrieved December 24, 2007, from Montana Chapter Website: http://www.fisheries.org/units/AFSmontana/SSCpages/Bluesuckstatus.htm

Confluence, Inc. (2007). *SH Dam Removal Conceptual Design & Planning Report.* Bozeman: Confluence, Inc.

MFWP. (2005). *Montana's Comprehensive Fish and Wildlife Strategy.* Helena, Montana: Montana Fish Wildlife and Parks.

MNHP. (2007). *Montana Field Guides.* Retrieved December 20, 2007, from Montana Field Guide: http://fieldguide.mt.gov

Montana Bureau of Mines and Geology. (1998-2007). *GWIC Well Construction Data*. Retrieved January 22, 2008, from Groundwater information Center: P:\2007\07-128 SH Diversion Dam Removal\Research\GWIC\Montana's Ground-Water Information Center (GWIC) Geographic Data V_11_2007.htm

NRCS. (2007, April). *Montana Soil Data Access.* Retrieved December 18, 2007, from Custer County area Montana: http://nris.state.mt.us/nrcs/soils/datapage.html

US EPA. (2007). *Water Quality Assessment for theTongue River Watershed, Montana.* Helena, Montana: U.S. Environmental Protection Agency.

US Geological Survey. (1998). *Natural Resource Information System - Montana.* Retrieved December 18, 2007, from Geology of Montana: http://nris.mt.gov/nsdi/nris/e00/geology55.zip

United States Geological Survey, 2004. Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02, Open-File Report 2004-1260 (http://pubs.usgs.gov/of/2004/1260/).

Figure 3: Water Resources

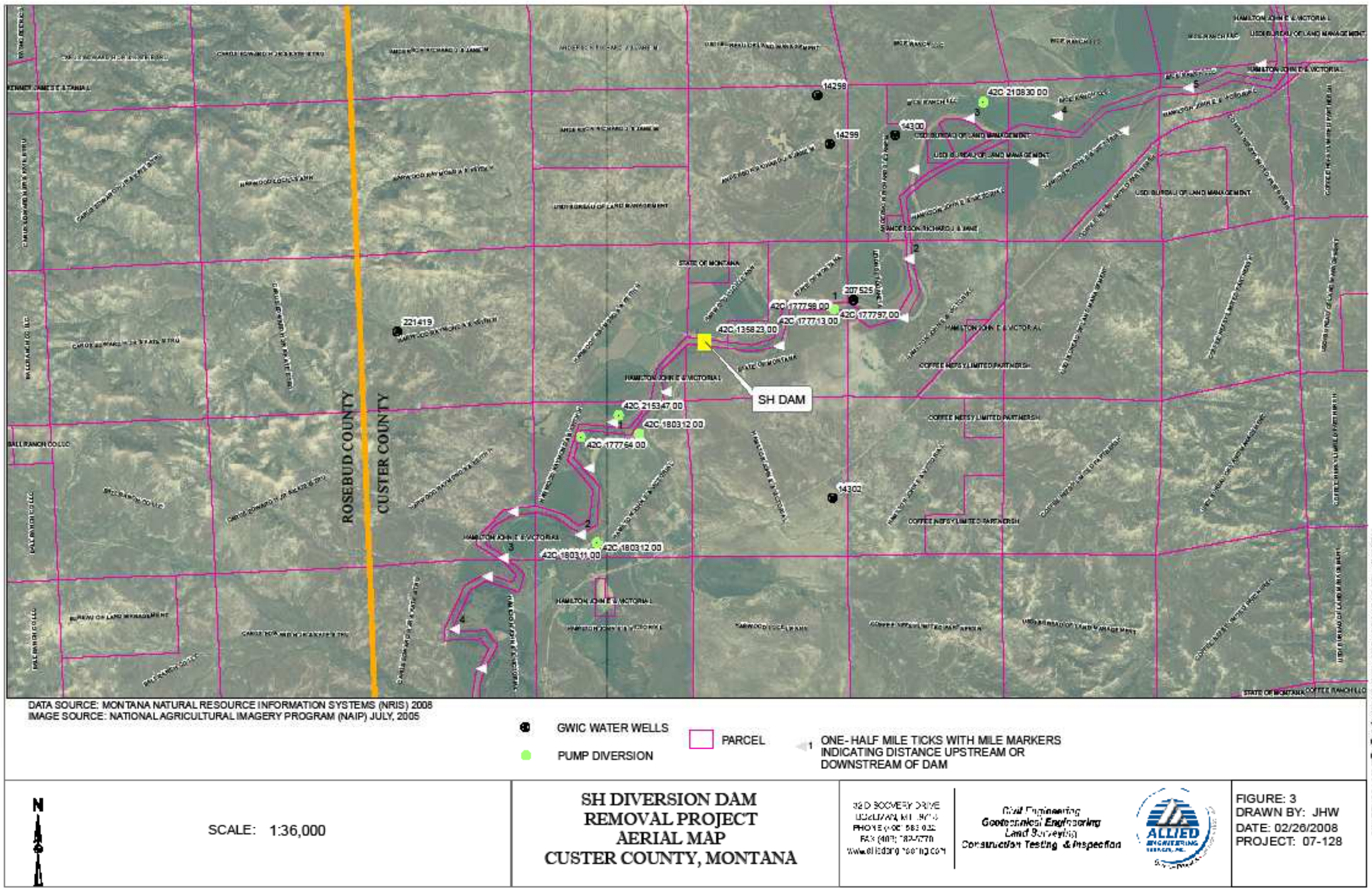


Figure 4: USGS Topographic Map

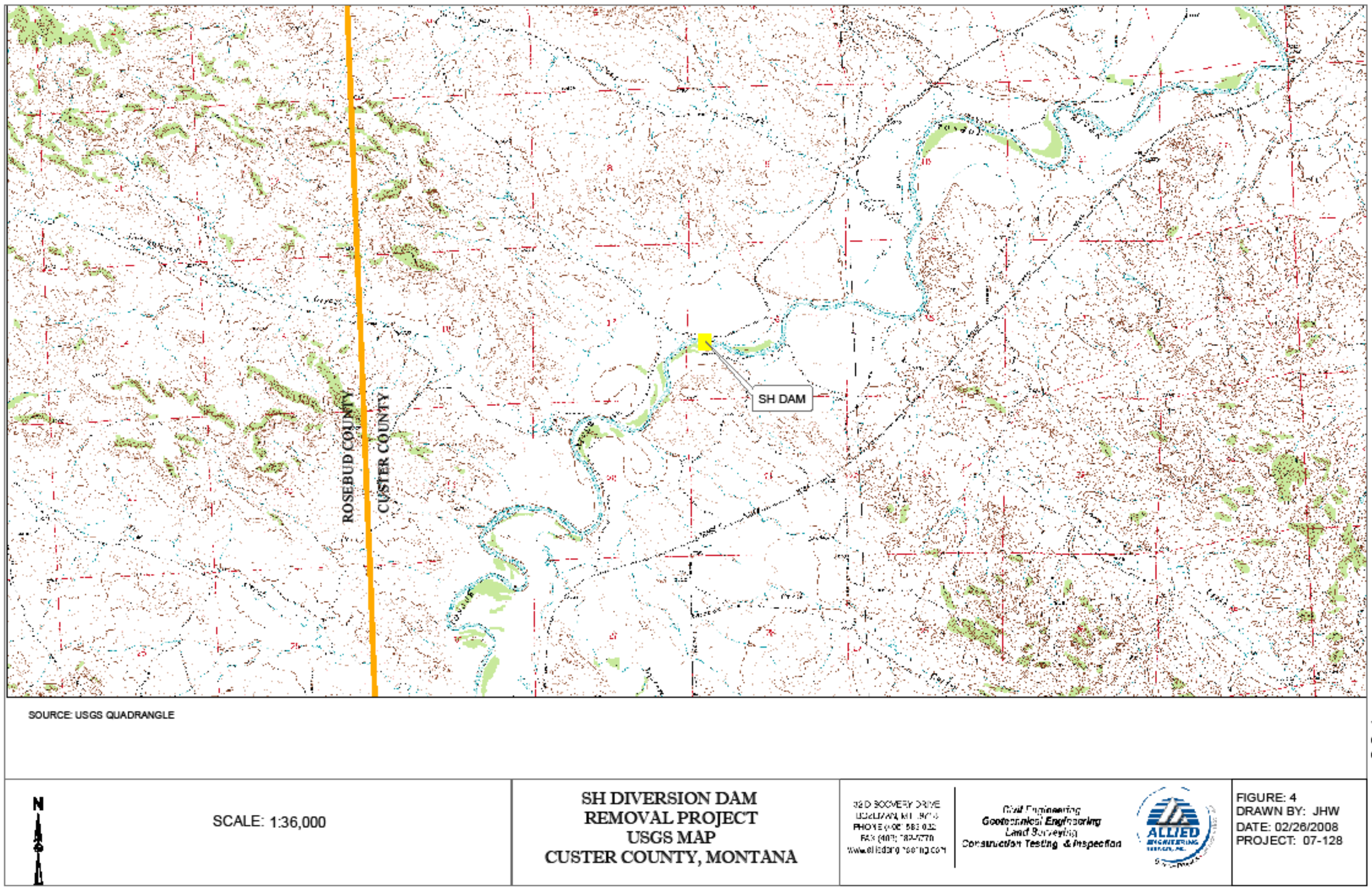


Figure 5: Site Aerial Map

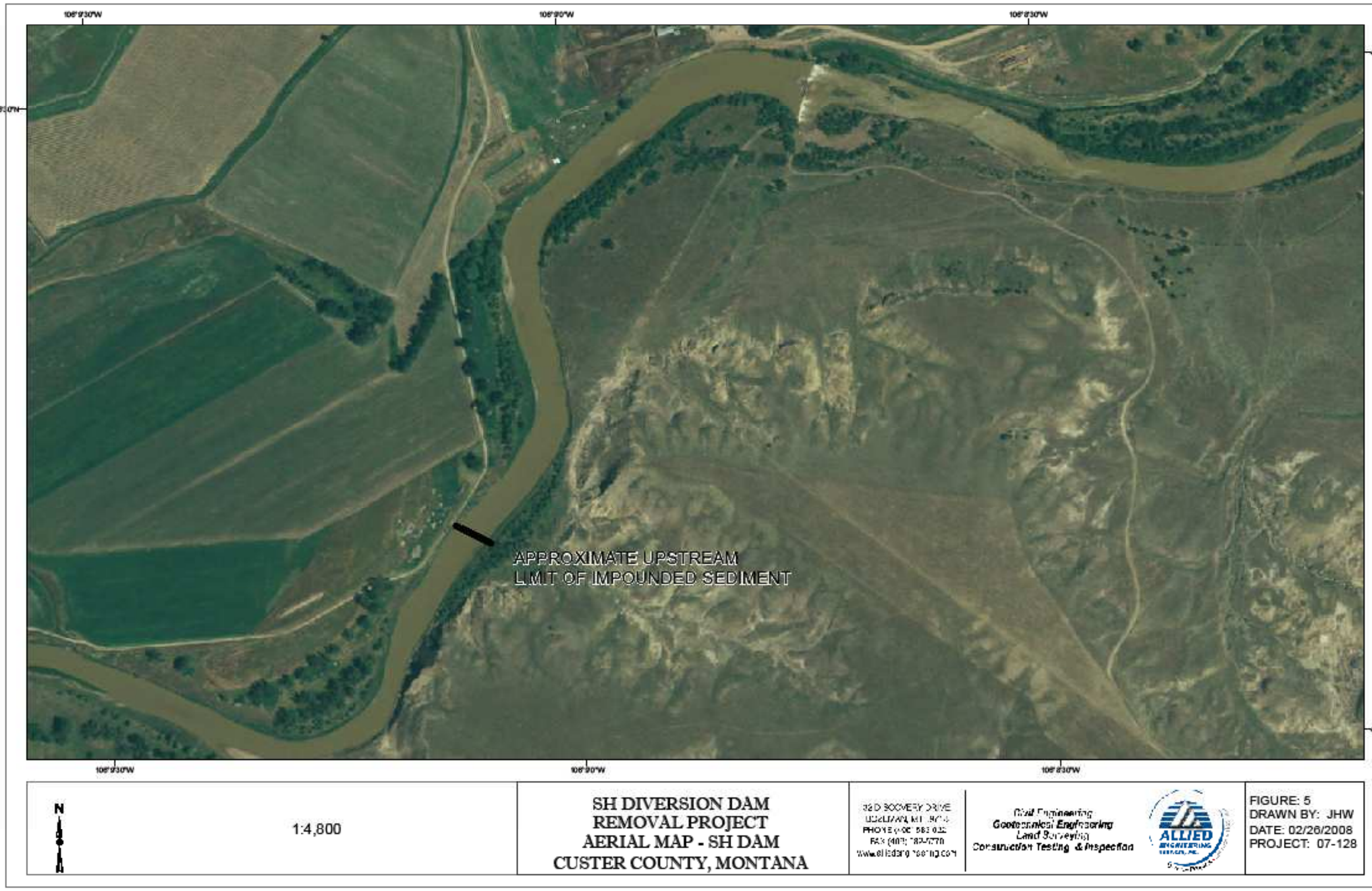
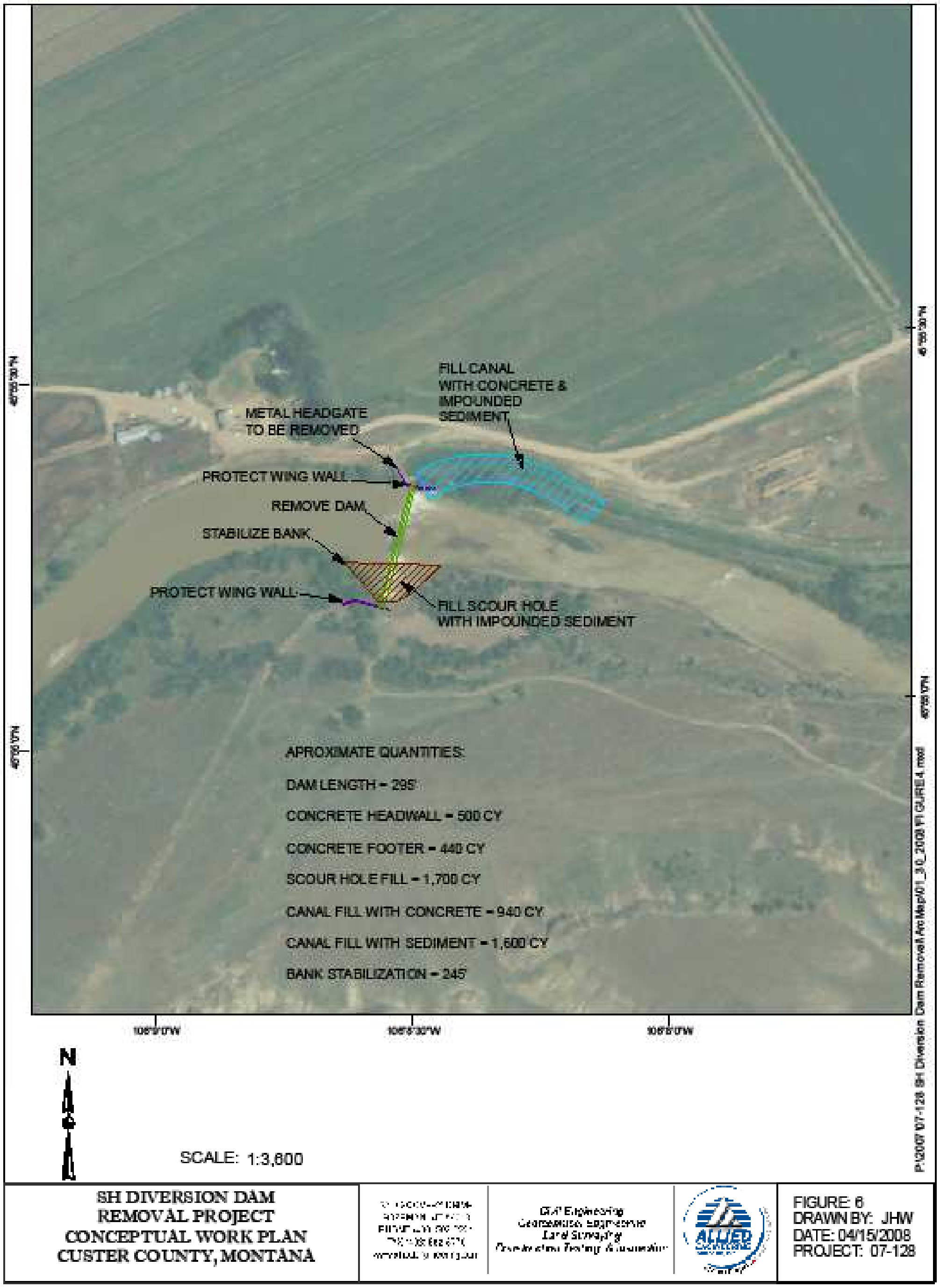


Figure 6: Conceptual Work Plan



APPENDIX A: Engineering Cost Estimate

SH Diversion Dam Removal Project
Engineer's Estimate

Unit Price Schedule

DAM REMOVAL & SITE WORK

					Alternative #2 Sediment Removal			Alternative #3A Sediment Release			Alternative #3B Sediment Release (Staged)			Alternative #4 Partial Release/Removal		
ITEM	DESCRIPTION	TOTAL QTY	UNIT	UNIT PRICE	QUANTITY	TOTAL		QUANTITY	TOTAL		QUANTITY	TOTAL		QUANTITY	TOTAL	
101	Removal of Concrete Structure (South Wingwall)	115	CY	$25.00	0	$0		0	$0		0	$0		0	$0	
102	Removal of Concrete Structure (North Wingwall)	70	CY	$25.00	0	$0		0	$0		0	$0		0	$0	
103	Removal of Concrete Structure (Headwall)	500	CY	$25.00	500	$12,500		500	$12,500		500	$12,500		500	$12,500	
104	Removal of Concrete Structure (Footer)	440	CY	$25.00	440	$11,000		440	$11,000		440	$11,000		440	$11,000	
105	On-Site Disposal of Concrete Structure - North Side	540	CY	$10.00	470	$4,700		470	$4,700		470	$4,700		470	$4,700	
106	On-Site Disposal of Concrete - South Side	585	CY	$15.00	470	$7,050		470	$7,050		470	$7,050		470	$7,050	
107	Sediment Excavation	42,000	CY	$2.75	42,000	$115,500		3,236	$8,899		3,236	$8,899		21,000	$57,750	
108	On-Site Disposal of Sediment - Cover Over Concrete Debris in Ditch	1,500	CY	$4.50	1,536	$6,912		1,536	$6,912		1,536	$6,912		1,536	$6,912	
109	On-Site Disposal of Sediment - Scour Hole	1,700	CY	$3.50	1,700	$5,950		1,700	$5,950		1,700	$5,950		1,700	$5,950	
110	On-Site Disposal of Sediment - State Land	3,000	CY	$3.50	0	$0		0	$0		0	$0		0	$0	
111	On-Site Disposal of Sediment - Fill Ditch - South Side (30 mile round trip)	16,300	CY	$10.00	19,300	$193,000		0	$0		0	$0		10,500	$105,000	
112	On-Site Disposal of Sediment - Fill Ditch - North Side (1 mile round trip)	19,464	CY	$4.50	19,464	$87,588		0	$0		0	$0		10,500	$47,250	
113	Bank Protection Along Scour Hole Fill	250	LF	$50.00	250	$12,500		250	$12,500		250	$12,500		250	$12,500	
114	Wetland Sod Removal in Canal (place over scour hole fill)	200	CY	$4.50	200	$900		0	$0		0	$0		100	$450	
115	Top Soil Removal in Canal (2000')	960	CY	$2.00	960	$1,920		95	$190		95	$190		95	$190	
116	Top Soil Removal on State Ground	430	CY	$2.00	0	$0		0	$0		0	$0		0	$0	
117	Temporary Access Road	470	SY	$3.50	470	$1,645		470	$1,645		470	$1,645		470	$1,645	
118	Dewatering	1	LS	$20,000.00	1	$20,000		0	$0		0	$0		1	$20,000	
119	Site Reclamation (Grading & re-veg of out of channel disturbed areas)	1	LS	$10,000.00	1	$10,000		1	$10,000		1	$10,000		1	$10,000	
120	Site Monitoring	3	YR	$5,000.00	3	$15,000		3	$15,000		3	$15,000		3	$15,000	
121	Site Maintenance for Irrigation Intakes	6	EA	$1,080.00	0	$0		3	$3,240		3	$3,240		3	$3,240	
122	Mobilization/Demobilization	1	EA	$15,000.00	1	$15,000		1	$15,000		2	$30,000		1	$15,000	
123	Best Management Practices per SWPPP	1	LS	$5,000.00	1	$5,000		1	$5,000		1	$5,000		1	$5,000	
						Subtotal	$526,165		Subtotal	$119,586		Subtotal	$134,586		Subtotal	$341,137
					Contingency at	25%	$131,541	Contingency at	25%	$29,897	Contingency at	30%	$40,376	Contingency at	25%	$85,284
						GRAND TOTAL	**$657,706**		**GRAND TOTAL**	**$149,483**		**GRAND TOTAL**	**$174,962**		**GRAND TOTAL**	**$426,421**

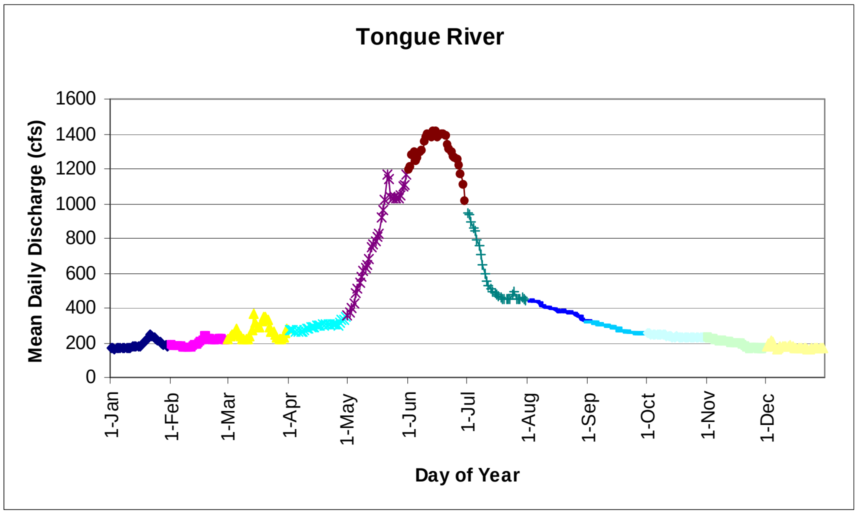
APPENDIX B: Sediment Analysis

In order to assess potential adverse impacts associated with sediment releases following dam removal, the volume of sediment currently stored behind the structure was compared to the average annual sediment transport capacity of the Tongue River at the project site, as well as the typical channel dimensions downstream of the structure. The results indicate that the volume of sediment stored behind the dam is approximately 25% to 42% of the total annual bedload transported by the river. Comparisons of the volume of sediment stored with channel dimensions indicate that conservative estimates of sediment delivery rates could result in up to 2 feet of mean aggradation downstream of the dam over a channel length of 0.8 miles. Although the dam removal will result in the delivery of accelerated volumes of sediment downstream, the available data suggest that this process will not result in long-term adverse impacts.

To estimate sediment transport capacity of the river, a generalized HEC-RAS hydraulic model was built using available cross-section data near and at the project site. This hydraulic model was developed using the computer program HEC-RAS version Beta 4.0. *Sediment Transport* Capacities were calculated using the Hydraulic Design tools within the model. Three available surveyed cross-sections were used to create the model; these cross-sections were duplicated at 1000- foot spacing and vertically adjusted to a slope of 0.175%. An assumed temperature of 55°F was used in the analysis.

Mean daily flow hydrology was developed for the USGS Gage Tongue River at Brandenberg Bridge near Ashland, MT (Gage No. 06307830). Approximately 19 years of record were used to determine the daily mean values. The average daily flows for the site range from a low of 158 cfs to a high of 1,410 cfs (Figure 6). The mean daily hydrograph shows a typical snowmelt scenario with baseflow conditions from fall through April, followed by a rapid increase in flows from early May through mid-June, and falling flows from mid-June through late July.

Figure 1 Mean Daily hydrograph for Tongue River at Brandenberg Bridge (USGS 06307830)



Two sediment gradations were used for the assessment. One gradation was derived from a bulk sample (5-gallons collected from the upper two feet of sediment at a location within 100-feet upstream of the dam (Confluence, 2007). The second sample consisted of a surface streambed material sampled upstream at the Brandenburg Bridge (USGS, 2004)

To evaluate the range of transport rates that would be described by different sediment transport functions, the bulk sediment gradation was assessed using modeled hydraulic conditions at the USGS cross-section near the Brandenburg Bridge. All five functions available in the HEC-RAS model were utilized, and the results compared. Of all of the rating curves generated (discharge versus sediment volume transported), the Meyer-Peter Muller (MPM) equation yielded the lowest transport rates. One possible factor for this result is that the MPM function is a bed-load only equation, while the other functions provide total sediment load (bed load and suspended load). Two of the functions (Yang and Engelund-Hansen) yielded a sediment rating curve about one order of magnitude higher than the MPM function, while the other two functions (Ackers-White and Laursen) yielded a sediment rating curve approximately two orders of magnitude higher than the MPM-derived results. The MPM function was selected as an appropriate means of conservatively estimating sediment transport through the Tongue River system.

In order to determine sediment transport rates, the model was run using the Meyer-Peter Muller (MPM) function to evaluate the effects of both channel geometry and gradation on sediment transport. A series of rating curves were developed to correlate stream discharge to sediment transport rate for a range of gradation/cross-section scenarios. For a given gradation, the difference in transport between the cross-sections was insignificant; however, results derived from the two sediment gradations depict a broad range of transport capacities.

An estimated range in the total annual sediment load capable of transport by the Tongue River at the project site was calculated by developing rating curves for both the bulk sediment gradation and the surface bed gradation using the MPM transport function. For each gradation, a daily sediment transport quantity was determined for each day of the year. The total annual sediment load in tons was then calculated by summing the daily values. Annual sediment transport in cubic yards was calculated by multiplying the load in tons by a factor of 1.26 tons per cubic yards. Based on the bulk gradation, approximately 100,000 cubic yards are transported annually, while approximately 170,000 cubic yards are transported using the surface bed gradation. Finally, the percentage of impounded sediment was calculated relative to the annual and seasonal transport capacity for both gradations. Table 1 provides a summary of these results.

Table 1: Summary of Estimated Seasonal Transport

Season			Over 1,000 cfs	Over 750 cfs	Over 500 cfs	Annual
# Days			41	55	68	365
Bulk Gradation	Natural Bedload	Tons Transported	52,118	62,899	69,270	126,475
		% Annual	41%	50%	55%	100%
	Dam Release	Tons Sediment	52,920	52,920	52,920	52,920
		% Season	102%	84%	76%	42%
USGS Gradation	Natural Bedload	Tons Transported	77,950	94,980	105,681	213,821
		% Annual	36%	44%	49%	100%
	Dam Release	Tons Sediment	52,920	52,920	52,920	52,920
		% Seasonal	68%	56%	50%	25%

It is difficult to accurately define the anticipated effects of sediment loading due to dam removal because the available information, both on-site physical measurements and research in the literature is limited. In particular, it is difficult to calculate the rate of sediment entrainment to be expected once the dam is removed. Since the sediment transport analysis for this project is based upon limited data reflecting only two sediment gradations and an assumed natural channel configuration, and since detailed effects from other dam removal projects in similar settings have not been identified, the results of this analysis should be considered approximate. Additional data and analytical procedures that would allow the development of a more refined sediment transport model include the following:

- Multiple sediment samples throughout the impounded sediment;
- Multiple natural cross-sections outside of the influence of the dam or roads,
- Multiple natural channel bed gradations outside the influence of the dam or roads; and
- Application of a more sophisticated sediment modeling procedure.

Approximately 42,000 cubic yards of sediment is impounded behind the dam. Based on results derived from the bulk sediment gradation, the impounded sediment represents 42% of the annual natural sediment bed load and 75% of the bed load cumulatively transported when average flows exceed 500 cfs (early May through mid-July). For the bed surface gradation, the impounded sediment volume represents 25% of the annual natural sediment bed load and 50% of the bed load typically transported during the early May through mid-July timeframe. Therefore, under either gradation scenario, the maximum amount of sediment potentially released during dam removal would be a significant fraction of the typical annual bedload transported downstream.

Previous studies of dam removal indicate that the erosion and transport of impounded sediment is not immediate upon structure removal, as the ultimate achievement of post-dam sediment transport equilibrium is related to the occurrence of high flows. The result is that sediment delivery typically occurs as a series of pulses. In the March 2005 issue of *Science Findings*, published by the Pacific Northwest Research Station, Gordon Grant, a geomorphologist and research hydrologist at the PNW Research Station, explains the process a river undergoes following the removal of a small dam:

> *Once the face of the dam is removed, the river drops over a waterfall of sediment and begins eroding toward the pre-dam channel. The sharp break in slope as the new channel cuts backward into the wall of sediment is called a knickpoint. At the time a small dam is removed, there is often a pulse of sediment entering the channel associated with the formation of the knickpoint. Additional pulses then coincide with the first major storms after the removal. Erosion continues in an episodic fashion until the wall of sediment that had accumulated behind the dam is broken down and the knickpoint gradually retreats upriver. Through this*

process, the river reestablishes its original gradient, though it may or may not return to its pre-dam riverbed.

This concept demonstrates that the time of year at which the dam is removed will play a part in how much sediment is transported immediately following removal.

Another means of assessing the potential impacts of sediment loading to downstream reaches is to consider the volume of sediment impounded with respect to the typical dimensions of the Tongue River channel. This allows a general estimation of the amount of cross-sectional area that the sediment would potentially occupy over varying channel lengths. Based on Cross-Section 7 of the Conceptual Design Report (Confluence, 2007), simple volumetric calculations indicate that if the 42,000 cubic yards of sediment was deposited over lengths of 0.8, 1.6, and 3.3 miles, the depth of accumulation would be approximately 2, 1, and 0.5 feet, respectively. This geometric exercise seems reasonable given that the average impounded sediment depth over the estimated 0.64 mile length of impounded sediment was calculated to be 2.3 feet. However, empirical evidence from other low-head dam removal projects suggests that much of the sediment stored behind these dams will remain in place. Prior removal projects indicate that a new floodplain or terrace feature will form within the formerly impounded area following dam removal. This sediment is then more gradually eroded and transported as a consequence of long-term channel migration.

Two pump diversions are located within the first five miles downstream of the dam The first pump location is approximately one mile below the dam and the second location is approximately three miles below the dam. Pump diversions float within the river and are typically removed from the river after the irrigation season is over. Further downstream (over five miles) there are permanent irrigation structures located within the river. Since empirical evidence from other low-head dam removal projects suggests that impounded sediment is transported episodically rather than as a single massive slug, it is anticipated that several miles downstream of the project site, the released material will be reworked with respect to grain size and spread as a relatively thin layer on the channel bed. Assuming that the pump diversions allow flexibility with regard to the timing and location of their use, no adverse effects to irrigation facilities are expected from the Proposed Action. The transported sediment mass profile is expected to decay both spatially with distance downstream of the dam and temporally over the course of several years. A small irrigation facilities maintenance budget has been included in the cost estimate of the Proposed Action; the maintenance would include monitoring impacts and addressing accumulated sediments at irrigation withdrawal sites.

With regard to overall stream ecology, some research supports the notion that the river ecosystem will quickly recover from the impacts of any sediment loading; however, this is by no means a certainty. It is important to recognize that the aquatic species within the Tongue River are accustomed to and thrive in a sediment-rich environment, such that bedload transport as well as increased turbidity due to elevated suspended sediment concentrations should not result in a long-term impact to aquatic life (Hubert, 1993).

The reach of the Tongue River immediately below the dam (about 2-3 miles downstream) is likely scoured below its pre-dam elevation (due to reduced sediment in flows downstream of the dam). As a result of the sediment depletion and resultant scouring, this reach of river exhibits a coarse bottom that provides habitat to catfish (Brad Schmitz, FWP Region 7 Fisheries Manager; personal communication, November 26, 2007). Once the SH Dam is removed and the impounded sediment load is transported downstream, it is likely that the reach below the former dam location will return to a channel bed dominated by fine sediments.

Based on the results of the sediment transport analysis, it is expected that there will be no significant long-term adverse impacts associated with sedimentation as a result of the Proposed Action.

References

Confluence, Inc., 2007. *SH Dam Removal Conceptual Design & Planning Report.* Bozeman: Confluence, Inc.

United States Geological Survey, 2004. Channel-Morphology Data for the Tongue River and Selected Tributaries, Southeastern Montana, 2001-02, Open-File Report 2004-1260 (http://pubs.usgs.gov/of/2004/1260/).

Hubert, W.A. 1993. The Powder River: a relatively pristine stream on the Great Plains. In: Restoration Planning for Rivers of the Mississippi Ecosystem. US National Biological Survey Biological Report 19